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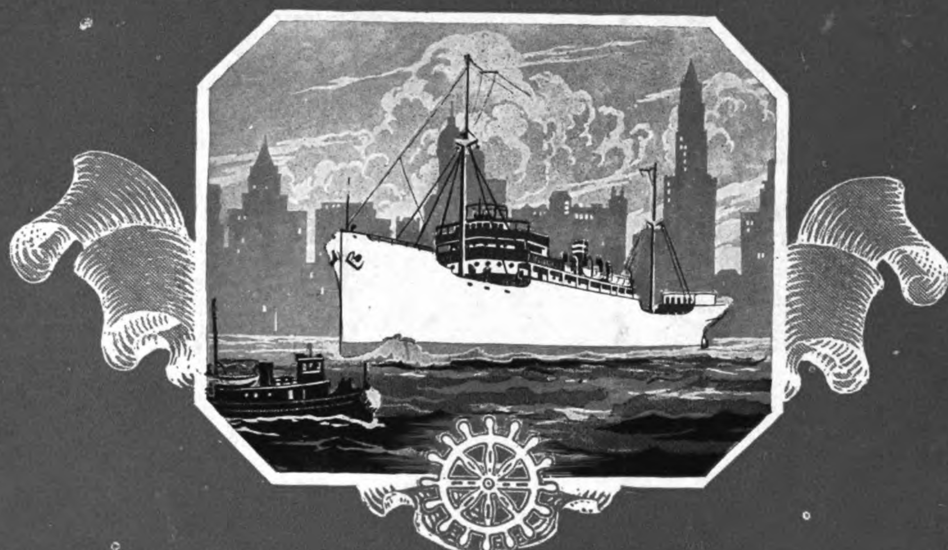

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Have the Shipping Board Conversions "Subsidized the Diesel Industry"?

Analysis of Conversion Charges on Vessels Completed to Date Shows Less Than One Third Directly Chargeable to Diesel Engine Builders for Main Engines

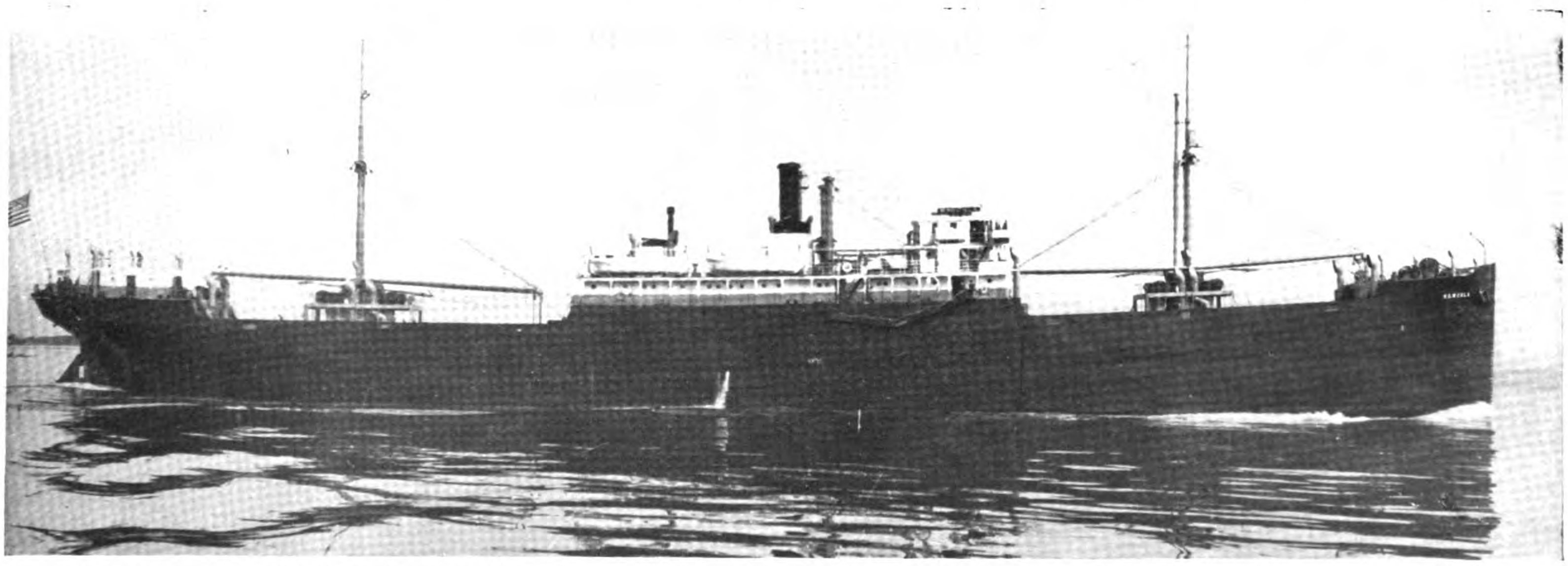
OUT of a total of about $8,943,590 which has been spent to date on the first portion of the U. S. Shipping Board's Diesel Conversion Program, only $2,569,430—less than one third—is directly attributable to the cost of building main propelling machinery, the installations of which alone with necessary auxiliary machinery would have been sufficient to turn the ships into moderately efficient freighters. This surely forms a direct refutation of the charge that the Shipping Board is subsidizing the Diesel industry, especially too, when we reflect that each engine was custom built to special, rigorous, specifications.

In a few weeks the last of the first batch of ships to be converted to Diesel power under the Board's $25,000,000 Conversion Program will be ready for sea service. The charge has frequently been made that these conversions represent nothing more nor less than a subsidy to the Diesel building industry. This charge from time to time has been denied with as much vigor as it has been pressed. The Shipping Board has very commendably published figures dividing the total cost of conversion of each ship into its logical component parts. These figures have been issued on the completion of each ship for sea service. Eleven out of twelve of such sets are now available.

A tabulation of these figures enables one to make some important deductions which not only refute the charge that the Shipping Board has subsidized the Diesel industry but which show conclusively that the ships in question have not been merely converted but rather have they been almost entirely rebuilt.

Less than one third of the total money expended has gone to the builders of the big main propelling engines, and even if we add the $931,400 expended upon the auxiliary machinery—generator, pump equipment, switchboard, etc.—the total amounts to but $3,500,830.

The total cost, which nobody for a moment can deny is large, has been dissipated in a variety of ways, which would not necessarily have to be expended upon the conversion of new ships. The ships converted for the board were taken out of the laid-up fleets and therefore their hulls had to be thoroughly overhauled in dry dock for weak rivets, bad spots in plates, etc. This amounted to well over $26,000 per ship, and was unnecessary in the case of two ships only, as will be seen. The total nevertheless amounted to some $25,760. There again there is a total of some $4,196,140—just under half the gross expenditure to date—charged off to Installation and to Special Alterations. The installation cost obviously included the work of putting the new machinery in the ship, but the "special alterations" included rebuilding the entire superstructure of all of the ships except three, and providing accommodation for some 14 passengers per ship, in addition to rebuilding the crew spaces. The $1,060,300 so spent was, in our opinion, well spent because it has definitely improved the ships, but it should be distinctly understood that this represents work totally unnecessary for straight conversion. It need never have been spent, but it was not spent in "subsidizing the Diesel industry." In the



"Special alterations" on this Shipping Board motorship, including reconstruction of the midship portion, amounted to $132,800. This has made her a better transportation unit, but is not strictly incidental to "conversion"

last three ships no passenger accommodations were fitted and in the WEST GRAMA no modifications were made to the crew quarters which were left in their original position in the poop of the ship. The board's figures show a total of $410,000 for "installations and special alterations" on this ship, so that it is impossible to determine exactly what was spent on special alterations here. The same applies to the SEMINOLE and to the YOMACHICHI.

In accordance with the plan of generally modernizing the ships all-electric deck auxiliaries were fitted and the old gear removed —an excellent plan, which, however absorbed some $322,300.

One of the most alarming items, however, is that charged off against traveling expenses, etc. This has eaten up no less than $365,000 which again formed no part of a "subsidy to the Diesel industry," but which was all counted in when the Shipping Board published its "terrific" conversion costs. The figures, as a whole, are interesting because they very definitely show that the Diesel industry has not been given a fair deal in this conversion business. Tied down by vigorous specifications making a custom job on a non-production basis, the industry has not been given a fair opportunity. Why, on batches of 10 engines there would be a reduction of over $40,000 per engine! This shows what can be done.

The figures are valuable, academically, because they indicate to private owners contemplating conversion work where the pitfalls lie.

While we may thoroughly commend the board for the sterling work done in this conversion work we feel that in their next attempts, unlike the Bourbons they will have "learned much and forgotten nothing."

Costs in Thousands of Dollars for U. S. Shipping Board Programme to Date

ITEMS	TAMPA	UNICOI	WEST HONAKER	WEST GRAMA	WEST CUSSETA	CROWN CITY	SAWOKLA	CITY OF RAYVILLE	CITY OF DALHART	YOMACHICHI	SEMINOLE
A Installation	210	210	265	410	265.09	265.09	227.15	227.15	220.1	400	436.28
B Special alterations..	125	125	137.4		137.4	137.4	132.8	132.8	132.5		
C Main engine and spare parts	212	212	228.5	228.6	228.5	228.5	247.33	247.3	247.3	247.3	242.2
D New shafting	9	9	.....	.....	......	......	......	......	......	......	......
E Deck machinery[1]....	29.3	29.3	29.3	28.9	29.3	29.3	29.3	29.3	29.3	29.3	29.3
F Repairs to hull.....	26	30	26.2	.....	26.2	26.2	26.0	26	35.5	35.5	......
G Equip. and outfit...	25	25	25	25	25	25	25	25	25	25	25
H Expenses[2], etc.	23	28	22	38	32	32	38	38	38	38	38
K Engine room aux.[3].	80.7	80.7	68	95	68	68	94	94	94	94	95
Totals	740.5	749.0	801.57	825.5	811.57	811.57	819.6	819.6	829.75	869.15	865.78

[1] Including Steering Gear, Motors, Control, and Cable.
[2] Includes "Engineering," Purchasing, Inspection, Traveling, Freight, Extras and Incidentals.
[3] Including Auxiliary Diesels, Generators, Pumps, Coolers, Switchboard, Cable.

Motorship Building Exceeds Steam by 100,000 Tons

THOSE of us interested in the progress of the marine Diesel have felt that the year 1927 was one of the most noteworthy in the history of the industry. That this optimism has not been undue is evident, because another gain is shown in the returns of motorship construction for the quarter ending December 31, 1927, according to returns issued by Lloyd's Register of Shipping. Under the present status, 100,000 gross tons more of this type of shipping are being built than of all other types combined. While the December quarter showed an increase of only 20,000 gross tons over the preceding one, the present total of more than 1,600,000 tons is over 700,000 tons greater than the aggregate building a year ago.

Further evidence of the increasing use of vessels equipped for motor propulsion is furnished by Lloyd's returns of the power of various types of marine engines being built or installed in all countries. Again the figures for oil engines show a gain over the previous quarter.

For the quarter ended December 31, last, the total indicated horse power of oil engines in hand for marine use was 1,233,956, as against 1,161,630 for the previous quarter. Of the present total, Germany is represented in the present figures with an indicated horse power of 241,300; and Italy with 161,050. A year ago, the power of all oil engines being built or installed in the world for marine purposes was nearly 400,000 i.hp. less than now.

A slight decline is shown in the figure for the indicated horse power of steam reciprocating engines, in comparison with the September quarter, the December total for all countries being 556,874, as against 568,969 for the previous period.

There was a gain reported in the figures covering the shaft horse power of steam turbines being built or installed; the total advancing from 309,900 in the September quarter for all countries, to 343,700 in the December period. The figures exclude Germany, returns for which are not available.

A decrease in the construction of tankers of 1,000 tons gross and above is reported by Lloyd's to have occurred during the December quarter. This is accounted for by a decline in this class of work in Great Britain and Ireland. Figures for the United States and the other maritime countries combined show a gain. Sweden alone, now has 83,300 gross tons of tank vessels building. It is noted, however, that the tanker tonnage now being constructed is more than double what it was a year ago, at which time only 371,520 gross tons were building of this type of ship.

"A Sidelight on Pulverized Coal"

IT has been pointed out to us by the Kennedy-Van Saun Mfg. & Eng. Corp., New York, that the source of our information, upon which was based the statement that the balls in the pulverizer in a pulverized coal burning plant are consumed at an average of 25 lb. of balls per ton of coal burned, is incorrect.

In this connection, referring specifically to the equipment installed on the Shipping Board freighter MERCER they state: "After the pulverized coal equipment was installed, the MERCER made a trip to New York, two demonstration trips in the Harbor, trip from New York to Philadelphia, and return, after which she went to Rotterdam and returned to New York. Since returning from Rotterdam, she has made another round trip to Baltimore and is expected to leave shortly for another trip to Rotterdam.

The total distance travelled is approximately 8000 miles. Not a single pound of grinding balls has been added to the pulverizers since the ship orginally left Baltimore and an examination of these grinding balls after the 8000 miles journeying, revealed that the wear was so small as to be scarcely measurable."

We hasten to give publicity to the above in order to correct any erroneous impression which may have arisen as to the specific performance of the MERCER as a result of our editorial article.

The article in question appeared on page 23 of the January issue of MOTORSHIP.

The Editorial Viewpoint

The U. S. Mercantile Marine

THE FUTURE OF THE U. S. Mercantile Marine, the fate of the U. S. Shipping Board, and the provision of suitable modern new tonnage all seem to be, at the time of going to press, in the melting pot. In fact, as Chairman O'Connor rather pithilly put it, while everyone is quarreling over who is to hold the reins, the horse gets weak. The matter has been brought before Congress but as yet no decision has been made. The Copeland bill is a constructive bill which definitely aims at a subsidy to privately owned shipping through an increase of Mail Subsidy. The Jones bill—perhaps the most constructive proposition yet made— makes for a definite continuation of the Shipping Board's operation of tonnage in addition to putting forward a big replacement. Many thoughtful people, students of economics rather than of politics, are coming around to think that continuation of the Shipping Board in business is the only real solution to the problem of providing the United States with an adequate merchant marine. There is a great deal to support this. Everyone realizes the evils of government operation and of government ship construction—the "terrific" conversion costs of the Dieselization program are examples of this—but at least the U. S. Shipping Board has accomplished something. U. S. Private Shipping (of a 100 per cent nature) in foreign trade today is miroscopic. The Shipping Board has the operating make-up of a net work of services stretching all over the world. The services represent a nucleus, and although starved pitifully of modern economical tonnage, they can be built up. Fast modern motorships will be required to bring them up to date. Prevailing sentiment among a number of men with whom we talked recently in Washington echoed this thought in no uncertain term.

Motor Transports

THE DIESEL ENGINES would appear to present almost an ideal form of propulsion for ships designed specially as troop transports. In the merchant navies of all nations there are ships designed with an eye to the possibility of their being chartered for the transport of troops but as far as we are aware the United States is the only country with a definite transport service. Many of the ships at present engaged in this service are old and uneconomical. Ships operating out of Pacific coast ports to the Philippines are, we understand, mainly coal burners and owing to the high price of coal at Pacific coast ports they are compelled to bunker sometimes at Moji and sometimes at Chingwantao, steaming off their course to do so. Apart from this it seems fundamentally wrong that a troop transport should have to depend upon foreign coal. The Diesel engined ship has economy of fuel which increases tremendously her radius of operation. She can fuel cheaply—at Pacific coast ports—can carry more troops than the corresponding steamer and in the tropics is an infinitely more pleasant ship to live in. As with the motor passenger liner the small uptakes permit of a big troopdeck practically unbroken from stem to stern which permits of easy movement of troops about the ship. The absence of standby losses, too, make for tremendous economy in the fuel item. Compact engine rooms (freed from any necessity of being built to tonnage regulations) will permit of maximum space for stores, etc. If and when money is appropriated for new construction for this branch of service it is certain that American Diesel engine builders will be given a chance of tendering. When built such a ship or ships would be noteworthy additions to motorshipping.

Conversion Problems

ELSEWHERE IN THIS ISSUE we talk about conversions of existing steamers to motorvessels. We describe a good moderate price conversion carried out recently for a private shipowner. We discuss the question of conversions generally and we also endeavor to arrive at some reasons for the apparently high cost of the first batch of Shipping Board conversions. These articles should be read carefully, because they are all intended to convey two messages:—Conversion, essentially, fundamentally and always, means compromise. Never judge the initial cost of motorships by the conversion cost of one. These might be established almost as definite axioms. Conversion work has necessarily commanded a very great deal of activity in world shipyards since the motorship came into being. The majority of such work has, however, been concentrated in American shipyards. We estimated in our November 1927 issue that to that date nearly a quarter of a million gross tons had changed or was changing to Diesel power in American shipyards. Much nonsense has been written about the conversion costs. The first Shipping Board conversion cost $60 per ton deadweight. A recent big tanker took her Diesel power for just over $42 per ton deadweight. The new Diesel-electric conversions will cost $130 per ton deadweight. A ship converted privately to Diesel power in 1923 was recently sold second hand, for $34.50 per ton dw. Each of these ships was converted in a different manner. The Shipping Board boats, being old hulls, had in the first place to have a lot of money spent on reconditioning their hulls. In the second place the Board saw fit, perhaps wisely, to put on a lot of "frills" which the ordinary shipowner would not have done. Remember that the Shipping Board conversions are special cases. The simplest, but not necessarily the most economical conversion, concerns the main machinery only.

Ship Operators

IT WAS DISAPPOINTING to note, during the recent hearings held at Washington by the U. S. Shipping Board with a view to helping to unravel some of the tangled skein of opinions and ideas which are all concerned with an American mercantile marine, such a minute representation of ship operators. The ship operator—as distinct from the shipowner—is almost exclusively an American production. He is the man who maintains and operates big fleets of foreign built and ostensibly foreign owned freighters in U. S. foreign trade. He knows, in other words, a great deal about private (as opposed to government) ship operation. He is conceivably the type of man around whom a private—and heavily subsidized—U. S. mercantile marine would have to be built. He represents a large number of foreign steamship lines carrying American goods out of American ports. He is, too, naturally very luke warm in his attitude as to the necessity for a U. S. mercantile marine. He carries, in association with foreign lines having direct representation in this country, all the foreign trade of the U. S. other than that handled by the Shipping Board lines and by the few privately owned ships. And many of these latter operate under foreign flags. He is the type of man who should have been well represented at the hearings to give reasons as to why it was impossible for him to operate U. S. flag ships. He is a factor of considerable importance in foreign U. S. shipments. He works quietly, efficiently—and makes money. One wonders whether he has really been taken into account in the various schemes which have gone forward on the mercantile marine question? One wonders, after listening to the various speeches made at the hearings whether there is any deep fundamental concept of the economic principles connected with the establishment of an American mercantile marine? One wonders whether it is generally realized that Australia and Canada have—each in a much smaller way—much the same shipping problems to solve?

Motorshipping Terminology

WE CONGRATULATE our contemporary the San Francisco *Shipping Register* upon its attempts to introduce into contemporary shipping literature a terminology which shall be cognizant of the changes which have come about since old "sail" shipping became steam shipping—long before steam shipping started to become motorshipping. Ships have changed, seamen have changed, but much of the old terminology correct in the days of sail still remains. The verb "to sail" is applied indiscriminately to fast modern motor liners and to the few remaining old timers still found on the seven seas. Our contemporary evidently thinks that this verb is no longer applicable to any mechanically powered ship. "With 200 passengers and general export cargo, the Nippon Yusen Kaisha liner SHINYO MARU steamed" it announces in a recent issue. In a previous issue we seem to remember having seen that the motorship "——" motored from San Francisco.

We like the spirit behind this attempt to modernize shipping terminology. It is particularly welcome at a period like the present when shipping is going through a period of transition far greater than that which marked the transition from sail to steam. We feel, nevertheless, that anyone who wants to revise shipping terminology has a big task in front of him. Everyone understands the old sonorous phrases and they will die hard. Then, again, there's the electric ship. She can't "sail," she can't "steam," she can't "motor"—if the ordinary motorship "motors." Surely we are going to have some terrible confusions and complications. "To sail" has at least the advantage of being nearly neutral. There is even at the present time no standardized spelling of the word which represents the Diesel engined ship. Many people still use "motor ship" although "motorship" is rapidly becoming recognized as the correct and logical thing.

This Era of Transition

MODERN SHIPPING, and particularly motorshipping, may conceivably have far more important effects than mere changes in terminology such as we have outlined above. Motorshipping is something new which strikes at the very roots of water transportation of freight and passengers. Even people whose interests lie necessarily and irrevocably with the steam propulsion of ships must agree that at least the marine Diesel is making its presence felt in the machinery layouts of steamships. It seems safe to predict that had the Dieselization of ships not been pushed with such vigor the majority of the world's goods would still be carried in slow inefficient 10-knot steam freighters, which according to Harry S. Scott of the General Steamship Corpn., San Francisco "are fast going into discard." The successful operation of steamship lines—he continues—"must either go ahead or go behind; they cannot stand still and the new development for the steamship business is modern Diesel fast tonnage." High pressure, high superheat turbines, pulverized coal, the use of the poppet valve to increase the efficiency of the steam reciprocating engine all represent developments which have been engendered by a desire to equal the economy of the Diesel engine. None has as yet succeeded although the shipowner and his advisers have given a very fair hearing to each steam improvement as it has come up for consideration. And yet in spite of this shipowners do not seem to be shaken in their faith in the motorship. Recently another prominent Pacific Coast shipping man—W. Leslie Comyn, president of W. L. Comyn & Co. Ltd.—went so far as to say, in special message to our contemporary *Shipping Register* that as far as Pacific trade is concerned "the day of the coal burning ship is finished, because the motorship with cheap oil and long distance trading is now the most economical form of transportation."

Diesels for Warships

ANY PROPOSALS for embarkation on a large warship construction program very naturally raise the question of the participation of the Diesel building industry in such construction. Diesels have been used in one form or another in naval craft for some time and a very fruitful market has been the supply of such prime movers to submarines. Submarines were, in effect, among the earliest and most successful of motorships. Many big capital ships, too, have had oil engine generator sets installed for standby purposes. It is only within comparatively recent years, however, that the question of using the Diesel for main propulsion has come to the fore. The big navies of the world have often been criticized by partisans of the Diesel engine for their apparent lack of interest on the matter. Such criticism has generally been unfair because nearly all big navies have had excellent opportunities of watching Diesel performance in the naval sense in their submarine departments. The difficulties which have stood in the way of the adoption of the Diesel for main propulsion of large warships appear largely to be concerned with the difficulties of obtaining the required power within proper limitations of space and weight. E. C. Magdeburger, aide on Diesel Engines to the U. S. Navy indicated some of the factors connected with Diesel warships in a thoughtful paper read last year before the Society of Naval Architects and Marine Engineers. We pointed out, last August, the economies earned from the fitting of Diesels to small cruising ships. Many cruisers are now fitting Diesels for cruising purposes. Modern auxiliary craft such as oilers, submarine mother ships, etc., are nearly always motorships today.

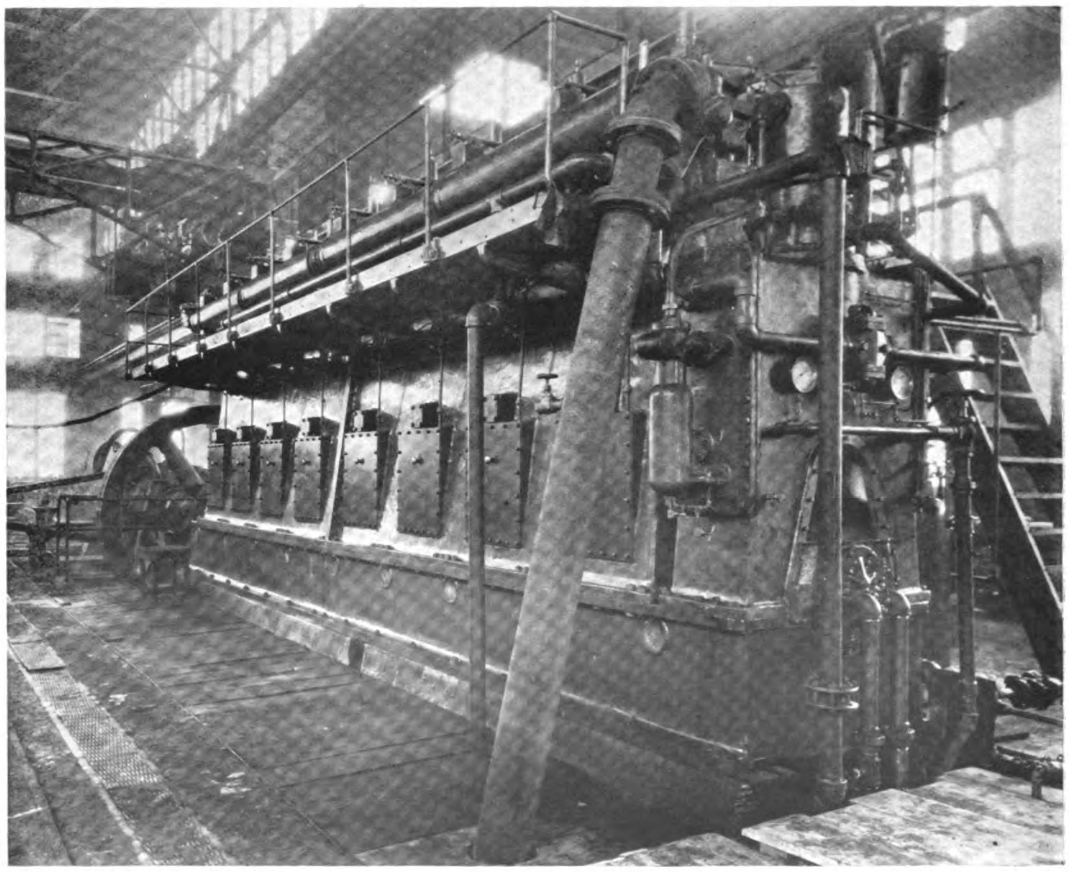
New Big Diesels for Panama Dredge

THE Fulton Diesel engines which are to be installed on the large Diesel-electric dredge for the Panama Canal are now on test and the dredge is expected to be placed in service shortly. There are four 8-cylinder, 900 hp. units coupled to Westinghouse generators. These supply current for driving the main pump motor and for all power purposes on the ship.

As we pointed out in the May, 1927, issue of MOTORSHIP, the dredge is under construction at Baltimore by the Ellicot Machine Corp. The hull has a length molded of 226 ft., a beam molded of 50 ft. and a depth molded of 14 ft.

Heavy duty will be required of the vessel in the Panama Canal Zone and three units will supply current for an electric motor driving a centrifugal, single-suction pump, with 26 in. diameter suction and 24 in. diameter discharge. She is to have an output of 2200 cu. ft. per min. of a mixture of water and solids with an average density of 75 lbs. per cu. ft. She must be able to dredge, in one swing, a cut 250 ft. wide at the full depth of dredging which is 60 ft.

The Diesel-electric dredge CLACKAMAS, operated by the Port of Portland, established a new non-stop record a short time ago with 63½ hours straight running. The dredge is working on the west side channel project off Swan island.



One of the four 8-cylinder 900 hp. 4-cycle Fulton Diesels completed for the new Panama dredge

Problems of the Converted Motorship

All the Most Important Factors Which Must Be Taken into Account Before and During the Actual Work of Conversion

THERE is no phase in this transition-marking motorshipping era standing more in need of elucidation and discussion than the conversion of steamers to motorships. It is, indeed, a proof of the present transitional stage through which shipping is passing, that conversion of steamers to motorships should be necessary. It is, for that reason, somewhat difficult to venture any definite expressions of opinion as to the pro's. and con's. of conversions. Remember, however, that conversion is no new phase in motorshipping. It commenced —in a small way— when motorshipping commenced. In 1917 Nobels of Russia started to convert their vast fleet of nearly 1,000,000 tons of steamers to Diesel drive. The first real conversion of ocean-going ships was that of three 500 tons dw. single screw steamers the PANGAN, BANDON and CHUMPON built in Great Britain in 1909. These ships were equipped with 6 cylinder $26\frac{3}{8}$ in. by $39\frac{3}{8}$ in. 4-cycle single-acting B. & W. Diesels of 1300 i.hp. at 100 r.p.m. which gave a sea speed of 9 knots on 8 tons of fuel per day. The original steam auxiliaries were retained. As steamers they used 34 tons of bunker coal per day.

Ms. Muncove, an early U. S. converted motorship, is powered by a 6-cylinder 925 hp. McIntosh & Seymour Diesel. She is now an economical motor coastwise freighter

It is fairly obvious to those who have had anything to do with the matter that at its best conversion means compromise. For this reason some converted motorships can never hope to obtain the same degree of success in general performance as an entirely new ship. On the other hand, there are many converted motorships which today have more than justified the expenditure of money, and loss of operating time to the ship during conversion by their wonderful economy and efficiency as carriers.

Then, again, in considering conversions we must remember that there are so many interpretations which an owner and his advisers put on the term "conversion." The United States Shipping Board, which to date is the world's largest converter of steam tonnage to Diesel power, maintains apparently the attitude that conversion is synonymous wih reconstruction. In this they may be partially justified because they have obsolescent steam tonnage to work on for raw material. One does enter a plaint, however, that in all fairness to the motorshipping cause, they might definitely announce this fact as part of the reason for the enormous bills they have managed to incur in the course of their conversion work in various shipyards.

The private shipowner, on the other hand, has not generally obsolescent steam tonnage to work upon. He takes good steam tonnage out of service deliberately for 5 or 6 months because he is looking to the future and senses that he will be more than compensated for the enforced lay time by the enormously decreased operating costs and improved operating efficiency of his Dieselized ship. But, in converting, he interprets the term "conversion" literally and beyond a replacing of his main and auxiliary machinery and the necessary modification to the tank top to provide new engine seatings, he does not go. Consequently he is able to get his Dieselized ship at a price at which he can pay off his costs in a reasonable time.

It does not seem too much to suggest that the Shipping Board has done incalculable harm to the cause of the marine Diesel by its neglect or forgetfulness to inform the world that it has been rebuilding obsolete steamers in a manner which no private shipowner could think of doing. The Board's Dieselization programme should be labeled a Re-building programme.

More steamers have been converted to motorships in American shipyards in the last two or three years than in the whole of the European shipyards for 10 years. America unquestionably knows more about motorship conversions than European yards. The reasons for this are not hard to seek, and are mainly concerned with the high costs of construction prevailing, coupled with a surprising — almost inspired— manifestation of conservatism on the part of coastwise shipowners. In European yards conversions have in the main been of an experimental nature. They have represented a gesture on the part of shipowners towards the Diesel engine—a preliminary tryout before building a larger ship. The Rottendam Lloyd Co., as was mentioned in a previous article, converted theii steamer TURBINIA into the motorship WIERINGEN with a view to collecting data for the construction of their big motorliner INDRAPOERA. The Netherland Ss. Co. of Amsterdam converted an 11-year old steamer—the BINTANG—to Diesel power and employed her on long freight hauls to the Dutch East Indies, prior to sending her to the Java Pacific Line service operating out of San Francisco. From that ship's performance they gathered no doubt much valuable data for their big motorliners P. C. HOOFT and CHRISTIAAN HUYGENS. In the case of each of these two companies the engines in the big ship were multi-cylinder units of the same design as the cargo ships engines.

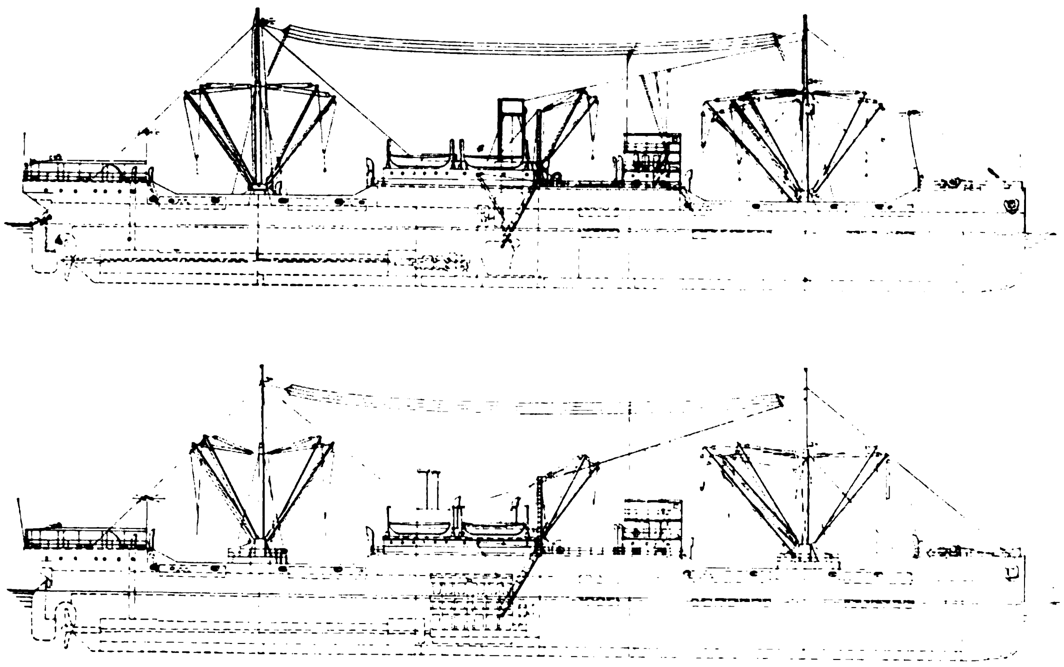
We may distinguish between such conversions—which are conversions of experiment—and those conversions which have led the Standard Oil group to take the steam power out of several of their best existing tankers and substitute Diesels. Such conversions are not experimental.

They are conversions for economy of operation. The companies concerned have realized that, with Diesel oil at the price at which they could obtain it, the motorship was a carrying medium whose economies they could not afford to neglect.

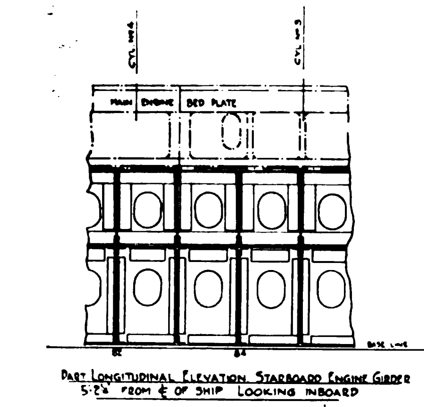
Then, again, both of these two conversions must be distinguished from the wholesale reconstructions to vessels scheduled for modernization under the $25,000,000 U. S. Shipping Board's Conversion Programme. The distinction to be drawn is very sharp. In most cases of private owners, conversions have been carried out on good modern existing steamers—operating and in service. The Shipping Board, however, was dealing with obsolescent steamer hulls, some of which had been laid up for seven or eight years. Therefore, the so-called conversion comprised restoration of the hull to sea-going service condition and modernization of the hull equipment—a matter in itself involving structural work—in addition to the work incident upon the removal of the old steam machinery and the substitution of the new Diesel machinery. The Shipping Board also saw fit and in modernizing and bringing up to date old steamer hulls, considered it necessary on most of the first batch of ships, to remodel all of the superstructure entirely providing excellent accommodation for 14 passengers. Whether this was wise, on ships which at the best could only hope to make 12 knots, is a matter upon which discussion could be raised. Probably at the time it was justified, although it was done at a time when the whole trend of first class cargo ship construction was towards speed—14 and even 16 knots. One modification certainly was justified and its value has been proven again and again in service. The winches were given remote control and raised on platforms round the mast base well clear of the clutter and mess of decks during unloading operations. It must always be patent that the Shipping Board in these rebuildings made some of the, at the time, most up-to-date and well equipped motorships in the world. This was done, however, at a figure which in no case was less than $60 per deadweight ton. The price was criticized most unfairly by numbers of people antagonistic to the Diesel engine. Their criticism was partially justified because they did not understand the difference between a conversion and a re-building. The Shipping Board, bureaucratically impervious and indifferent to criticism, made not the slightest attempt to enlighten the shipping public.

Having discussed something of why people carry out conversions, we may start off with the premise that exactly what is involved in a conversion depends largely upon the wishes of the person converting and upon the skill of the shipyard and architects involved. Henry Ford, for example, in converting steamers to motorships, displays almost a prodigality (in the eyes of the general shipping public) in the luxury of the fitting which he lavishes upon his reconditioned hull. Many tank ship owners have contented themselves merely with a replacement of the main machinery, knowing that they still required a certain amount of steam for tank heating and steaming. Such people, morever, have continued to use steam for the windlass and warping winch on deck and for the cargo pumps. Such a policy is eminently sound—for tankers—and, in the case of one U. S, conversion brought the price of conversion down in the nature somewhere of $40 per deadweight ton. Note in passing that a tanker is a definite case where, in converting, there is no addition to the cargo carrying capacity of the ship. A moment's consideration will show this. The conversion work is confined entirely to the portion abaft the cofferdam where there are no summer tanks. Moving of bulkheads and alteration in the size of tanks is entirely a matter outside the scope of ordinary conversion work and is unnecessary.

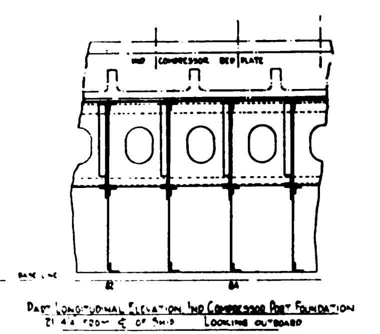
Indeed, it must be admitted, that in one particular case the tanker, as a Diesel engined ship, had to have some of her cofferdam (at the top) moved forward in order to accommodate a new boiler room. The pushing forward was occasioned by the size and height of the main engines. These were of greater power than the old steam plant in order to secure an extra knot of speed. On the other hand, another converted tanker powered by a pair of special, high speed, short stroke Diesels driving a single shaft through gearing (the whole, forming a wonderfully compact unit), was able to retain two of her old boilers on

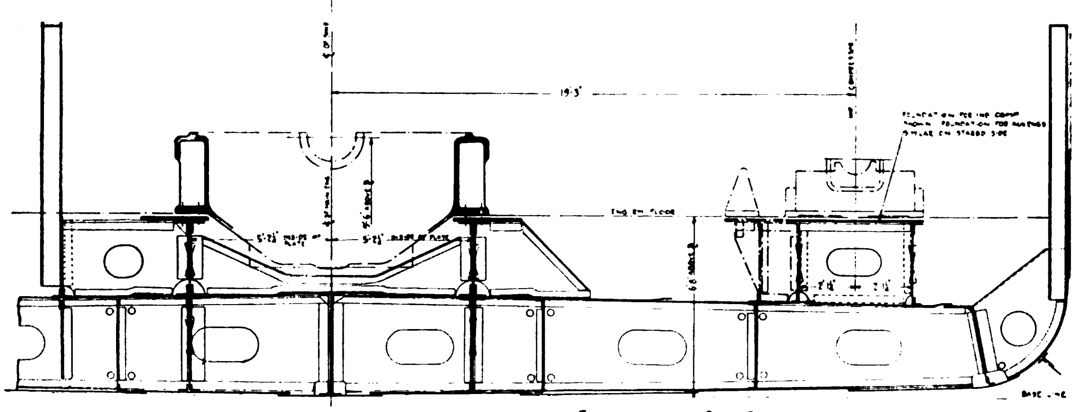


This shows the Seekonk, converted, in 1923, with her original steam machinery and with her existing 1770 hp. Cramp B. & W. Diesel. Notice her efficient but unusual stern



Adaptation of Existing Tank Top for Diesel Power





The heart of a conversion is the engine seating. This shows the arrangement adopted by Bethlehem Sb. Co. for a 6-cylinder 2700 hp. McIntosh & Seymour Diesel in an ex-steamer 410 ft. by 54 ft. by 29.7 ft. now operating in round the world service

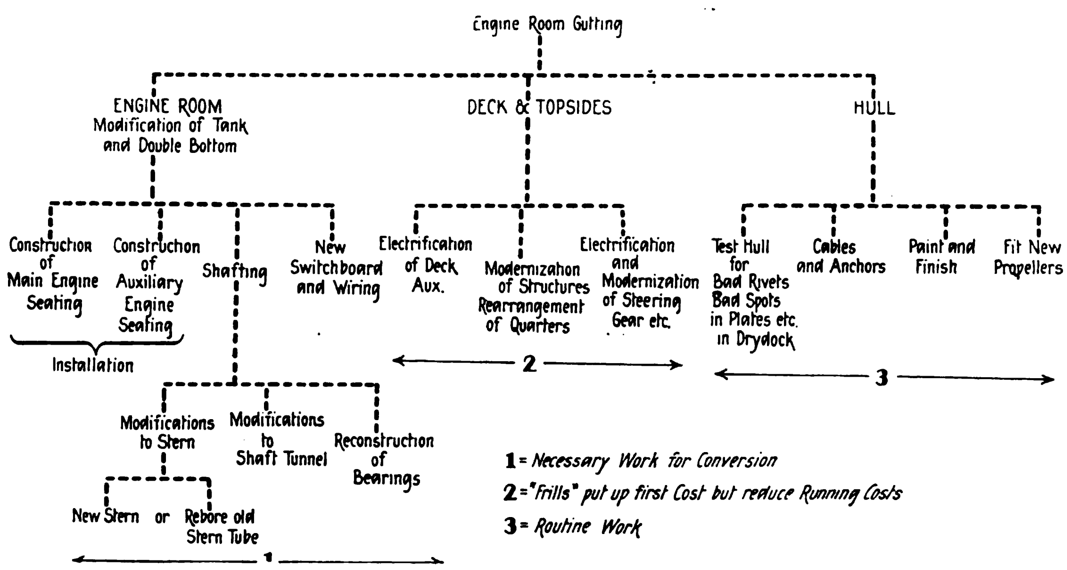
Comparison of Cargo Ship as Steamer and as Motorship

	Steamer	Motorship
Gross tonnage	5948 tons	5959 tons
Net tonnage	3823 tons	3703 tons
Displacement (load)	13,010 tons	13,010 tons
Endurance or operating radius	14,000 miles	14,000 miles
Total deadweight capacity	9550 tons	9120 tons
Fuel oil	1878 tons*	760 tons
Lubricating oil	......	16 tons†
Fresh water	330 tons	164 tons
Net cargo capacity (full endurance)	7330 tons	8180 tons
Net cargo capacity (half endurance)	8440 tons	8660 tons
Power—main engine	2200 s.hp.	2900 s.hp.
Service speed (about)	9.9 knots	11½ knots
Gain of time on full endurance	......	5½ days
Passenger accommodation	......	11 passengers

*Steamer has to use deep tanks as oil bunkers for 14,000 miles operation. (This may be compared with New York-Buenos Aires-New York 11,742 miles or New York-Manila-New York 22,728 miles via Panama.) †Only 3.2 tons will be consumed for all purposes in 14,000 miles.

the engine room floor level. This tanker had originally geared turbines and three Scotch boilers. The center boiler has been removed and the "gear" end of the two Diesels tucks away very neatly between the two boilers. The vessel has a deadweight of 10,200 tons and with about 2850 developed s.hp. makes about 11.1 knots at load draft. The installation is wonderfully compact and speaks much for the advantage of this form of geared drive. The tanker in which part of the cofferdam was "invaded" is a big 15,000 tonner with over 3000 hp. In both these cases the conversion price was considerably lower than with the Shipping Board ships. But remember that a tanker is one of the cheapest type of ships to convert anyway because it needs so little structural alteration. More care has to be exerted over the question of correct design of seatings, however, because tankers are very apt to be "tender" with vibrations.

The ordinary freighter is a different case when it comes to conversions, and there is generally a definite gain in cargo carrying space due to the elimination of big settling tanks or of cross coal bunkers. Then, in the upper 'tween decks, there is often a gain in space because the casings can be narrowed and the boiler casing is eliminated. In any case, the gain in space, though useful and valuable, is not tremendous. The converted freighter Wm. Penn was credited, after conversion with an additional 10,000 cu. ft. of cargo space due to the elimination of the boiler casing, saddle back, etc. The Shipping Board converted motorship Tampa had a cargo deadweight capacity of 7330 tons as a steamer, which was increased to 8180 tons as a motorship. Another Shipping Board conversion, the West Honaker, had her "endurance" on inner bottom tanks increased from 7300 miles to 17,600 miles. As the table shows, the Tampa—as a steamer—required to have space for bunkering 1878 tons of fuel oil whereas today she need only carry 760 tons of Diesel oil. With this capacity she has an operating radius or "endurance" of 14,000 miles. In her present service from New York to Australia and India out via Panama and home via Suez—a total of some 26,540 miles, she can take on board at Panama sufficient oil to carry her right back to New York and down to Panama again. The surplus is carried in the deep tanks. No steamer could possibly possess such "endurance" without bunkering three or four times—with attendant dirt and delays. This advantage, with the attendant economy of operation of the Diesel is the strongest argument for ship conversion by far.

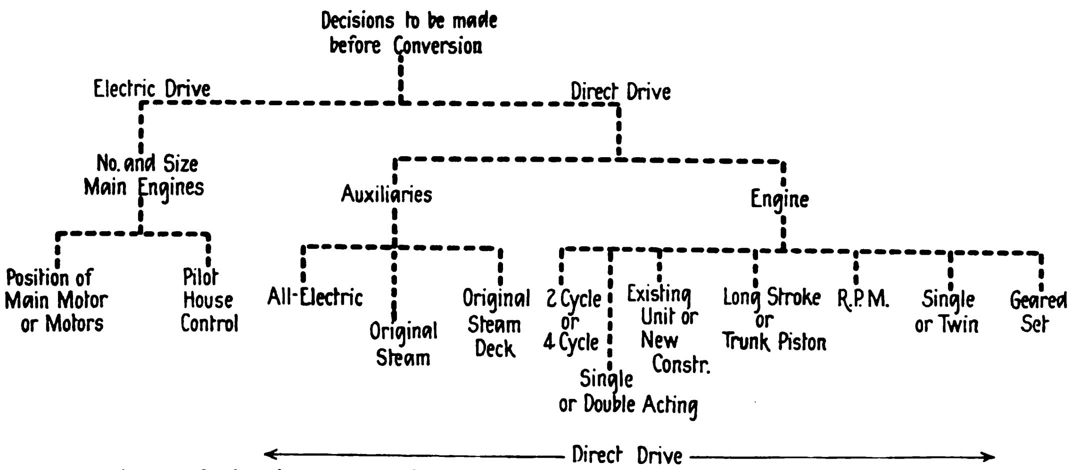


Comparative analysis of work for conversion—part unavoidable and part mere "luxury"

When an owner decides to convert an existing steamer he has at once a number of problems confronting him. Shall he step up the speed? What kind of engine shall he use? Obviously here it will be to his advantage to select an engine which needs least modification to existing line and tail shafting. An alteration in rake of shafting frequently has meant raising the height of the shaft tunnel and remodeling the thrust recess. On the Tampa, for example, because there was a higher shaft line in the new engine, it proved necessary to raise the top of the shaft tunnel in order to provide sufficient headroom in the shaft tunnel. Between the thrust recess and a point about 3 ft. aft of the bulkhead at the aft end of cargo hold No. 5, the arch of the tunnel was cut off and raised, extension pieces inserted in the tunnel frames and a shutter strake used on both sides to close the gap in the plating, the whole being riveted and all joints welded. With the new shafting new bearings on raised stools were necessary. This serves to give an idea of just one of the cumulative problems which conversion brings in its wake.

Having selected an engine and decided on a slight step up in speed the converter has then to decide on a single or twin screw installation. Generally if the ship is a single screw ship to start with it remains a single screw ship because you can get all the power you want on a single screw today and it saves a lot of structural alterations. In the case of the Diesel-electric dredge Sandmaster, however, a modification was made to the stern and twin screws were fitted. The ship is an ex-Lake type Shipping Board freighter. An electric motor was coupled to each screw. Even when a decision on the number of screws has been made, there still remains the question of the kind of engine. There are naturally choices to be made of operating cycle, single or double acting—in fact all the problems which confront the man who is planning a new motorship with the additional difficulty of having first a given predetermined unalterable set of characteristics to work with. Whereas, in designing a new

(Continued on page 116)



Comparative analysis of preconversion problems, showing various courses open to the converter

The Future Supply of Fuels for Marine Oil Engines*

That "hardy annual"—the possible and almost immed ate shortage of fuel oil—has recently made its appearance in shipowning circles. We know that there is no immediate danger of a fuel shortage or even any danger for many years. The shipowner is not always so well informed. He fears moreover that, in trusting his fleet to the oil companies tender mercies, his fuel bill is likely to soar—at any moment. No one, surely, is better equipped to make a reassuring statement on these matters than a representative of one of the world's largest oil companies. That is why the substance of Mr. Michler's A. S. M. E. paper is very important. No men are better able to make authoritative statements on the present state of affairs than world leaders in the oil industry. That is why prominent men have sent us their well-considered opinions—for publication—which we reproduce on the next page.

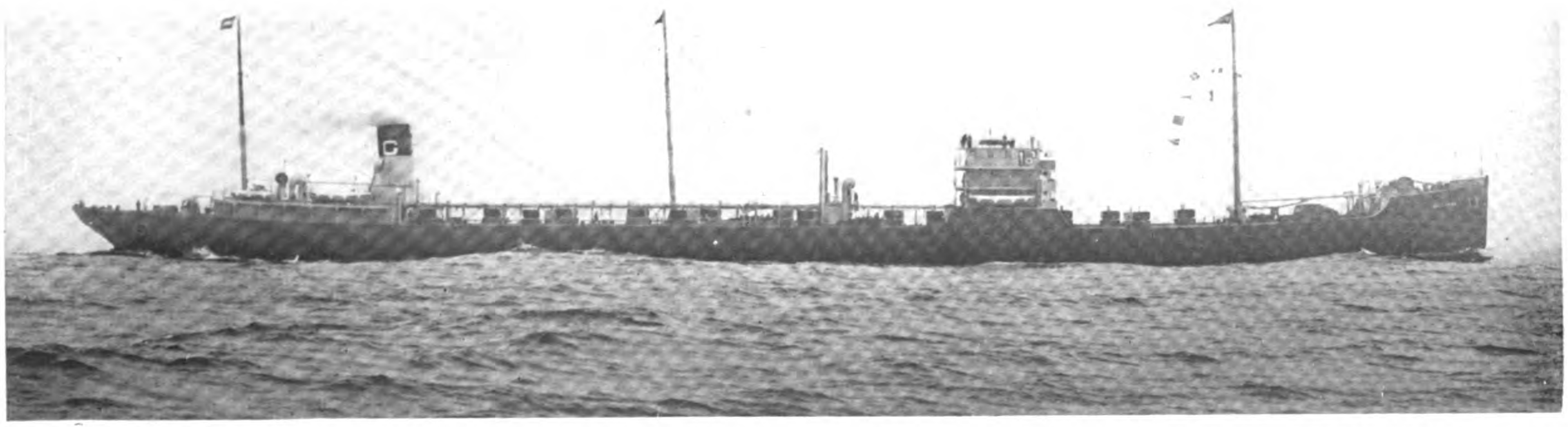
IN discussing the future supply of suitable fuel for the Diesel one looks at it not wholly from the standpoint of one interested in selling Diesel Oil, but as a representative of the Standard Oil Company (New Jersey), a user of the Diesel engine to a large extent in its operations, which is therefore sympathetically interested in the progress and future of this type of engine. In fact, most oil companies today are actual users of Diesel engines in their plants or in connection with their transportation facilities, such as pipe lines in which Diesel engines are utilized to a large extent for pumping, and in their tanker fleets for water transportation of oil in bulk. Six years ago today, the company which I represent had just two Diesel tankers in operation. Today more than one-third of the entire fleet is Diesel driven. In that period of six years, our construction program has been practically concentrated upon building or converting tankers to Diesel propulsion. I do not know of any more striking example of our interest in the successful development of the Diesel engine or of the faith which we put in its future.

The question arises in the minds of the more skeptical as to whether our position is truly representative of the average shipowner. People will say that it is all very well for an oil company controlling its own manufacture of Diesel oil to feel assured of a supply of that product adequate to the needs of its own ships; but, they say, how about the average shipowner who has no such security of economical supply of fuel for his engines in the future? This question has caused some concern to shipowners, principally European, who have been pioneers in Dieselization. When you consider that these men are taking what is really a double gamble in buying tonnage of a type which calls for a higher construction cost in some countries and which is not convertible to steam propulsion except at considerable expense, it is easy to understand why the question of a future adequate and economical supply of fuel oil for Diesel engines is a matter of real concern to them.

I can see no reason to doubt that there will be in the future an adequate supply of oil suitable for Diesel engines to take care of even the growing demand, nor is there any justifiable reason to feel that the price will go above the level where Diesel engines can favorably compare with steam machinery burning coal.

In examining the reasons for offering this assurance. we must first consider the supply outlook on crude petroleum. Admittedly, predictions of future crude supplies are hazardous. Up to the present time it has been practically impossible to gauge supplies of crude oil as accurately or to produce oil under the more or less certain conditions that govern mining operations, such as coal or iron, where the deposits and their extent are well known and fairly stable. We have experienced in the past, periods of low production with consequently high per barrel costs of the crude produced. We have alternately experienced periods of flush production. In the latter instance, properties are sometimes held by numerous owners and intensive drilling take place in an effort by each owner to recover the deposit of oil before it is drained by his neighbors. Unwieldly production results in petroleum products thrown on the market sometimes considerably in excess of the actual demand. During such periods, efforts are made by refiners to store crude oil but there is naturally a limit to the amount of crude that can be financed and carried in storage, and the great expenditure represented by this operation places a heavy burden upon the petroleum industry. Today we are experiencing just such a period of over-production, and the chief sufferers are the oil companies. It is the opposite situation, curtailment of supplies, which the consumer has to worry about. Looking at the picture of actual and potential world crude oil supplies today, there is nothing to justify concern on the part of the consumer. Outside of the tremendous present production in America, in the midcontinent fields, Texas and California, new production is being brought in with great future possibilities in South America—Venezuela, Colombia and Peru. Production in Roumanian fields, curtailed during the War, has been stimulated and is coming back into its own. Prospects for future production in Russia are tremendous. Marked improvements in drilling and in methods of recovery give promise of more thorough extraction of oil deposits than in the past. In

*Being the substance of a paper read by Gordon H. Michler, of the Standard Oil Co. (N. J.), before the American Society of Mechanical Engineers, New York.



Oil companies themselves are backing up their confidence in the future supply of Diesel fuel by equipping their carrying fleets with motorships

brief, there seems every indication from the standpoint of crude supply of sufficient production to meet every essential need for many years to come.

Granted that the prospect of future crude oil supply is satisfactory, what direct relation does this bear to an adequate supply of fuel? They are one and the same thing. Viewed in the broader aspect, every barrel of crude oil is at least 90 per cent potential fuel. Look at a cross section of a representative barrel of crude oil composed of 42 gal. In running this barrel of crude for finished products, we will say in round figures, that one gallon is lost in processing; one gallon is manufactured into wax and miscellaneous specialties; one and one-half gallons are converted to lubricating oil. We have accounted so far for three and one-half gallons of the original barrel of crude; the remaining 38½ gal. or 92 per cent of the total, is available for fuel of one kind or another. In diagnosing the various fuel uses, we can say that on an average 3½ gal. are used for lamps and stoves, commonly spoken of as kerosene. We are now down to a balance of 35 gal. Out of this approximately 15 gal. are utilized as fuel for internal combustion engines for automotive use. This product we refer to as gasoline. We are then left with 21 gal. out of the original 42, or 50 per cent of our working stock which is available for fuel for either surface ignition or Diesel engines, or for burning under boilers to generate steam. If you look at this picture of representative disposition of products manufactured by normal distillation processes from an average barrel of crude today, I believe you will agree there is very little likelihood of a shortage of the fuel in which you are interested.

But, you say, what about the ever increasing demand for fuel for automotive uses? This demand last year increased 16.24 per cent over the preceding year for domestic consumption and exports from the United States combined. And, this was only in keeping with the steadily rising curve of demand over a number of years. To meet this call for more automotive fuel, you have all heard of modern scientific methods, such as cracking, which make it possible to extract a greater gasoline yield from each barrel of crude. Concern as to a future economical supply of fuel for Diesel engines is based chiefly upon the question whether the growing demand for automotive fuel coupled with cracking will not increasingly limit the balance of fuel available for other purposes, thereby leading to prohibitive prices for such fuel. Considered from all angles, there is no good reason to think so.

In the first place, are we sure that the demand curve for automotive fuel will continue upward indefinitely? Today the automotive and petroleum industries are making progress in the development on the one hand of high compression motors and on the other hand of fuel suitable to their operation, the combination of which should lead to most decided economies in fuel consumption. The main problem in this connection confronting the automotive industry is twofold: The development of a motor designed to deliver power obtained by higher compression and secondly, designing a motor of small bore and stroke together with high revolutions per minute in order to insure power from such a motor. The part of the problem with which the petroleum industry is concerned is developing a fuel capable of withstanding this increased compression. Actual progress has been made by both industries towards solution of this problem. It would not be too optimistic to say that these developments may lead to an increase of up to 100 per cent mileage attainable on automotive fuel based upon the average mileage attainable today. Conversely stated, the possibility exists of getting the same mileage as at present with a conservation of 50 per cent of automotive fuel. Naturally this will go a long way toward curbing the upward trend of demand for this kind of fuel and indirectly operate as a safeguard against cutting down on stocks of fuel for other purposes to a point of creating prohibitive cost.

The second safeguard is furnished by the economies in fuel consumption represented by the Diesel engine itself. We have already mentioned the ratio of fuel consumption of one to three in the larger units, that is, marine Diesel engines, as compared to oil-burning steam driven ships of comparable tonnage and horsepower. Hence, every million horsepower changing from steam to Diesel operation makes available enough oil fuel for 3,000,000 Diesel horsepower. With this in mind, the question naturally arises as to the trend of present day ship construction. Is this trend sufficiently in the direction of Diesel construction to warrant the feeling that it will have

Reassuring Special Telegrams to Motorship from the Oil Industry

E. W. Sinclair
President, Sinclair Consolidated Oil Corp., New York

"In my opinion there is no reason to believe that there will not be sufficient crude oil produced to meet the gasoline and Diesel oil requirements for many years to come, at a reasonable price to the consumer."

J. Howard Pew
President, Sun Oil Co., Philadelphia, Pa.

"In view of the enormous proven reserves of crude oil in the ground and of recent improvements in geological and geophysical methods as aids in discovering oil it is inconceivable that at any period within the next century an adequate supply of Diesel oils at moderate prices will not be readily available."

L. T. Barneson
President, General Petroleum Corp., Los Angeles, Cal.

"In my opinion there will be an ample supply of Diesel fuel for the next 25 years."

Sir Henry Deterding
Chairman, Royal Dutch-Shell Combine, London

"There is as much certainty nowadays as to the permanency of adequate supplies of Diesel fuel oil as of coal. In fact as strikes cannot affect oil supplies, Diesel oil supplies are more reliable. That we don't preach this but believe in this as a faith is proved in that we have sold practically all our ocean steamers and replaced them by Diesel boats. In the long run greater efficiency is with the Diesel boat in all respects."

W. L. Mellon
Chairman, Gulf Refining Co., Pittsburgh, Pa.

"The production of crude oil in the United States is the largest in the history of the industry. With improved scientific methods for the discovery of new fields of oil and improvements in drilling devices making deeper drilling possible, we feel there will be an ample supply of all grades for many years to come. In addition to the production in the United States the countries in Central and South America are barely scratched and we have reasons to believe will produce large quantities of crude oil in the future."

Axtell J. Byles
President, Tidewater Oil Co., New York

"There can be no doubt of an abundant supply of Diesel fuel for many years to come."

K. R. Kingsbury
President, Standard Oil Co. of California, San Francisco

"I am convinced that liquid fuel will be available for internal combustion motors over a very long period."

Richard Airey
U. S. Representative, Asiatic Pet. Co.

"I am of the opinion that ample supplies of Diesel oil will be available for the next 25 years and will be more than sufficient to take care of the requirements of Diesel motor vessels built during that period. Actually a large increase in Diesel motor vessels will be of great assistance to oil refining for the reason that the ever increasing demand for gasoline will necessitate an increase in cracking of heavy oil. This will increase enormously the supply of Diesel oil and enable it to be obtained at reasonable prices."

P. N. Harwood
Vice-president, Pan-American Petroleum and Transport Co., New York

"If any one is today raising the hypothetical question as to a possible shortage of oil for fuel he is entirely disregarding the facts as to world-wide petroleum production and new methods of recovering oil developed during the past two years. These facts as to the continuance of petroleum supply for a long time to come have been irrefutably established by the United States Bureau of Mines."

any real effect on conservation of fuel? Lloyds Register of Shipping reports that Diesel construction has now increased to be in excess of steam construction. These figures show a very decided trend toward Diesel construction. They are important to the subject which we are considering as they represent an additional element in fuel conservation. In brief, the tendency in marine construction today to replace steam plants with Diesel plants with a two-third fuel saving in operation is another important factor in insuring an adequate supply of suitable fuel for the Diesel engine in the future.

Now consider for the sake of argument, a situation where in spite of the economies in fuel consumption which we have just discussed, there might be, for some reason or other, a stringency in the supply of fuels for different uses, resulting in higher prices. What would be the first logical effect? By examining the various uses of oil for fuel we find that there was sold in 1926 as boiler fuel for generating steam in shore plants in the United States, 214,731,000 barrels of what is generally known as Bunker "C" Fuel Oil. In addition there was sold for the same purpose, 53,615,000 barrels of crude oil. A great deal of these 268 odd million barrels was sold in direct competition with coal. With moderate advances in the cost of crude petroleum and Bunker "C" Fuel Oil resulting from conditions which we are now picturing, some of this shore plant consumption could be advantageously converted back to the use of coal. This is particularly true in sections of the country in close proximity to coal producing areas. Under such conditions, should they ever come about, a great deal of this Bunker "C" Fuel Oil could, by advanced refining processes, be worked up into suitable Diesel Oil. In this event, every million horsepower in steam changing from oil burning to coal burning would make available enough oil fuel for three million Diesel horsepower. Also, a large percentage of the crude oil made available by the turning over to coal could be run for Diesel Oil. In other words, should a condition arise which we find it difficult to visualize today, and an actual shortage of oil fuels occur, resulting in higher prices, is it not only natural to assume as a matter of common sense economics that the result would first be felt in the field of the most highly competitive fuel uses—that is, in operations where fuel oil comes into direct competition with coal on practically even terms on the basis of today's prices. In case of an advance in oil prices, the operator of Diesel engines has the least to fear from competition with operators using solid fuel, such as coal. His margin of advantage is too great. Take as an example a ship owner operating vessels out of New York harbor. Suppose he can purchase coal at about $6.50 per ton trimmed in bunkers. On a basis of evaporation efficiency alone 4½ barrels of Bunker "C" Fuel Oil will do the work of this one ton of coal. This means that oil at $1.44 per barrel under boilers is equal in thermal efficiency to his $6.50 per ton coal. We can figure that his other advantages in burning bunker fuel oil, such as quick turn around in port, economy in bunker space on ship permitting greater freight earnings due to more cargo space, savings in wages and victuals for stoke-hold crew and space for their accommodation, and less wear and tear on machinery—these additional advantages from oil burning warrant his paying 25 per cent more for his fuel oil. In other words, when we consider thermal efficiency plus other economies of burning oil under boilers, $1.80 per barrel bunker oil at New York is the equivalent to $6.50 per ton coal. This economy is very much greater still, where fast passenger mail liners are concerned. Now consider the position of the Diesel operator who is getting the same results on one barrel of Diesel oil as the steam operator gets out of three barrels of heavy bunker fuel oil. The Diesel operator can afford to pay three times $1.80, or $5.40 per barrel for his fuel before he is on a parity with the steam operator burning coal at $6.50 per ton. I admit these figures are in a sense, theoretical. They have been worked out by marine experts on the basis of their actual operating experiences on coal, bunker fuel oil and Diesel bunkers. I say they are theoretical because actual operating costs will vary considerably in the different trade conditions under which ships operate. Even allowing for such differences, these figures do show conclusively that the Diesel operator has the least to fear from steam competition burning coal in the case of an advance in oil prices whether this advance be gradual or immediate.

Problems of the Converted Motorship

(*Continued from page* 113)

motorship to suit your requirements, you can figuratively speaking build up your engine room (with an eye on tonnage measurements) around your engines—main and auxiliary, an existing steamer has a certain size of engine and boiler space, certain well defined double bottom characteristics into which a Diesel engine must be fitted.

For this reason much greater care must be taken in the choice of an engine. One of the greatest dangers in conversion work comes from a tendency on the part of owners to underpower their ships. This has been the case with one or two towboats. The result has been that the engine has proved unable to stand up to the work and there has been a resultant general condemnation of the Diesel. It is unwise for an owner, when arranging to power a conversion to pick some standard make of engine with an apparent rated power near to that which he wants. The powering for a conversion requires even more careful selection than that for a new construction.

Then, above all, there is the question of seatings for the new main and auxiliary engines. Here, again, a compromise has to be made with existing conditions. One has the old steamer tank top and foundations to play around with. There are the new weights and different distributions of weight of the Diesel machinery to consider. The possibility of vibrations has to be taken into account.

Possibly the best solution to the problem lies in removing tank top floors and intercostals entirely in way of the new engines and in substituting new material. The principal opposition to this lies in the question of cost.

It would be idle to deny that trouble has been encountered in converted motorships over that question of new engine seatings—sometimes owing to unwillingness upon the part of the owner's advisors to agree to sufficiently heavy scantlings. This is now being overcome to a great extent and satisfactory jobs have been carried out by extending intercostals and floors vertically upwards and then by means of heavy angle stiffeners and strong rider plates forming a pair of strong box girders, running fore and aft and intimately connected with the ships tank structure. In some cases the space between the hollow girders has been used as the sump tank for the main engine.

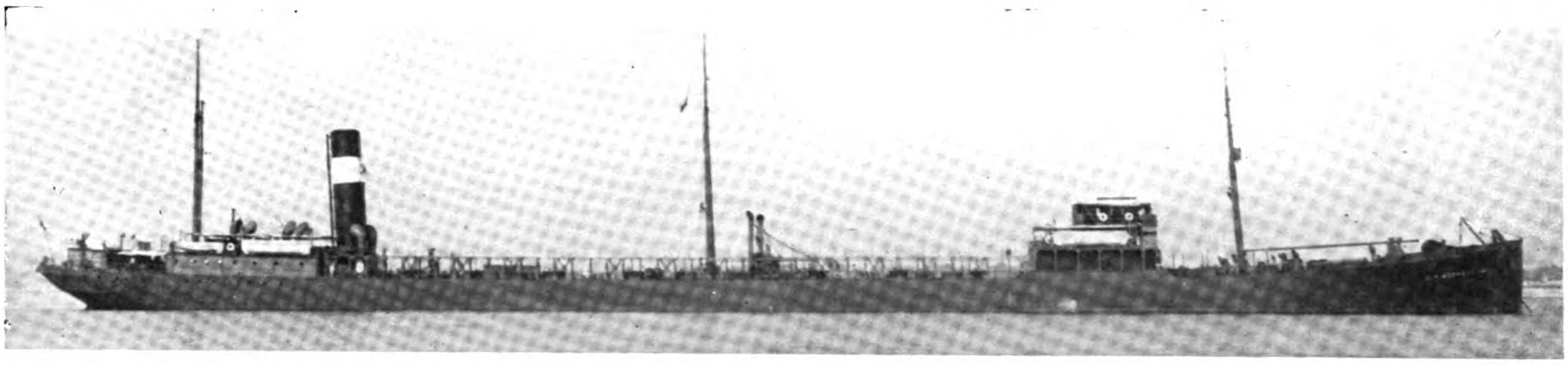
The two tables of comparative analysis on page 113 give an idea in handy form of the work involved in a steam-motor conversion. The smaller of the two attempts to assess the problems confronting the owner of a steamer when he is proposing to convert one of his ships. Even once the actual choice of drive has been settled there remains the question of the type and make of engine, the choice of auxiliaries, etc.

The larger table assesses the work actually carried out once the choice of drive and engine has been made. It assumes the old engine room gutted—the starting point: We can conveniently divide this into three portions, No. 1 of which is the more or less regular routine work of conversion, No. 3 of which concerns ordinary work to be done on the hull and depends, naturally for its volume upon the condition of the hull when delivered to the converter's yard. No. 2 covers the frillings. In converting a tanker, these are not necessary at all. In converting a freighter they obviously depend upon the amount of money the owner wishes to expend and upon the degree of modernization he wishes to build into his ship. Remember that in conversion the main saving comes from the small fuel consumption of the main engine. A converted steamer, even with the steam auxiliaries (deck and engine room) left in her, can operate more cheaply than a full steamer.

In any case remember that conversion is essentially compromise and that the price of converted motorships delivered for service bears no direct relation to the price of new tonnage. Even between one conversion and another there is no distinct relationship. Much depends on the owner and on his service requirements.

An interesting small yacht installation was that made in the EL MISTICO, a 44 ft. cruiser built by the Ballard Marine Railway of Seattle for E. Michelson of the Seattle Yacht Club.

It is powered with one of the new 4-cylinder Fairbanks, Morse Diesel engines developing 40 hp. at 650 r.p.m. A unique feature of the job is the special unit control stand designed by Fairbanks, Morse engineers through the use of which the engine can be started, the clutch manipulated, the speed regulated and the reverse operated by the man at the wheel.



Converted Motor Tanker J. A. Moffett Jr.

The Standard Shipping Co. Is Now Operating in Its Coastwise Trade Large Tanker with Twin 2-cycle Diesels

An opportunity has been recently given to the shipping world to inspect conversion work as carried out for a private owner. The ship in question is now one of the largest and most powerful motor tankers in service. Tietjen & Lang Drydock Co. plant of the Todd Shipyard Corp., New York, completed this contribution to motorshipping last month by converting the J. A. MOFFETT JR., owned by the Standard Shipping Co. to Diesel drive.

She is a big tanker constructed by the Federal Shipbuilding Co., Kearny, N. J., as recently as 1921 and is a sister to the E. T. BEDFORD converted to Diesel power early last year. We understand that the conversion cost was considerably below that of any of the Shipping Board conversions. Modifications to superstructure were naturally reduced to a mimimum.

Smoke stack, fidley top, main engines, boilers, pumps, auxiliaries and shafting were removed from the vessel. The outer stack, one condenser, two radiojets, condensate pump, feed pump, feed water heater, two oil heaters, filter box grease extractor, inspection tank, distiller and steam generator were reconditioned and replaced in the vessel.

The two main engines are Hamilton-M.A.N. units built by the Hooven, Owens, Rentschler Co. at Hamilton, Ohio, and are 4-cylinder, 2-cycle, single acting, air injection, 1650 b.hp. units at 90 r.p.m., each with attached 3-stage tandem compressor, one double-acting scavenge pump, salt water cylinder cooling pump, fresh water piston cooling pump, and lub. oil pump. These are described in detail on page 120.

The three auxiliary engines are also M.A.N. type built by the C. & G. Cooper Co. at Mt. Vernon, Ohio. The engines are 3-cylinder 12 in. dia. x 18 in. stroke, 4-cycle,

Characteristics of Ms. J. A. Moffett Jr.

Length bp.	499.2 ft.
Beam mld.	68.1 ft.
Depth mld.	30.5 ft.
Gross tonnage	9563 tons
Net tonnage	5978 tons

airless injection units 150 s.hp. at 260 r.p.m.

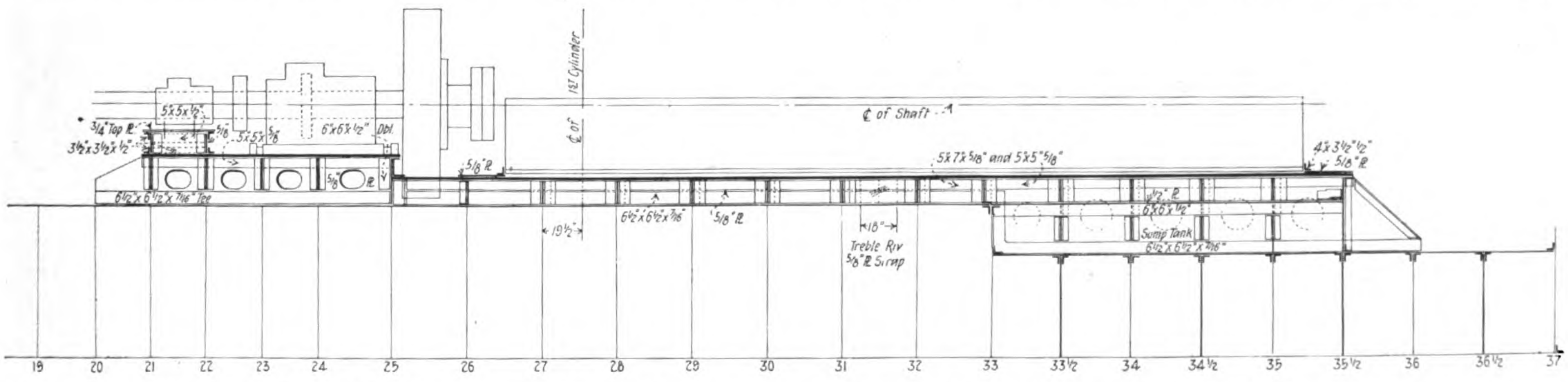
There are two 50 kw. generator compressor sets, the capacity of compressors being 200 cu. ft. of free air per min. each, and one 100 kw. generator set.

The contract for converting the J. A. MOFFETT JR., was signed in January 1925. We understand, however, that the owners found it somewhat difficult to release the vessel from service for the necessary conversion work, consequently the engines were delivered in June of 1927 and the vessel in July, allowing two and one half years to prepare the necessary plans and purchase the equipment. The entire equipment was purchased, installed and guaranteed for one years by the Tietjen & Lang Co.

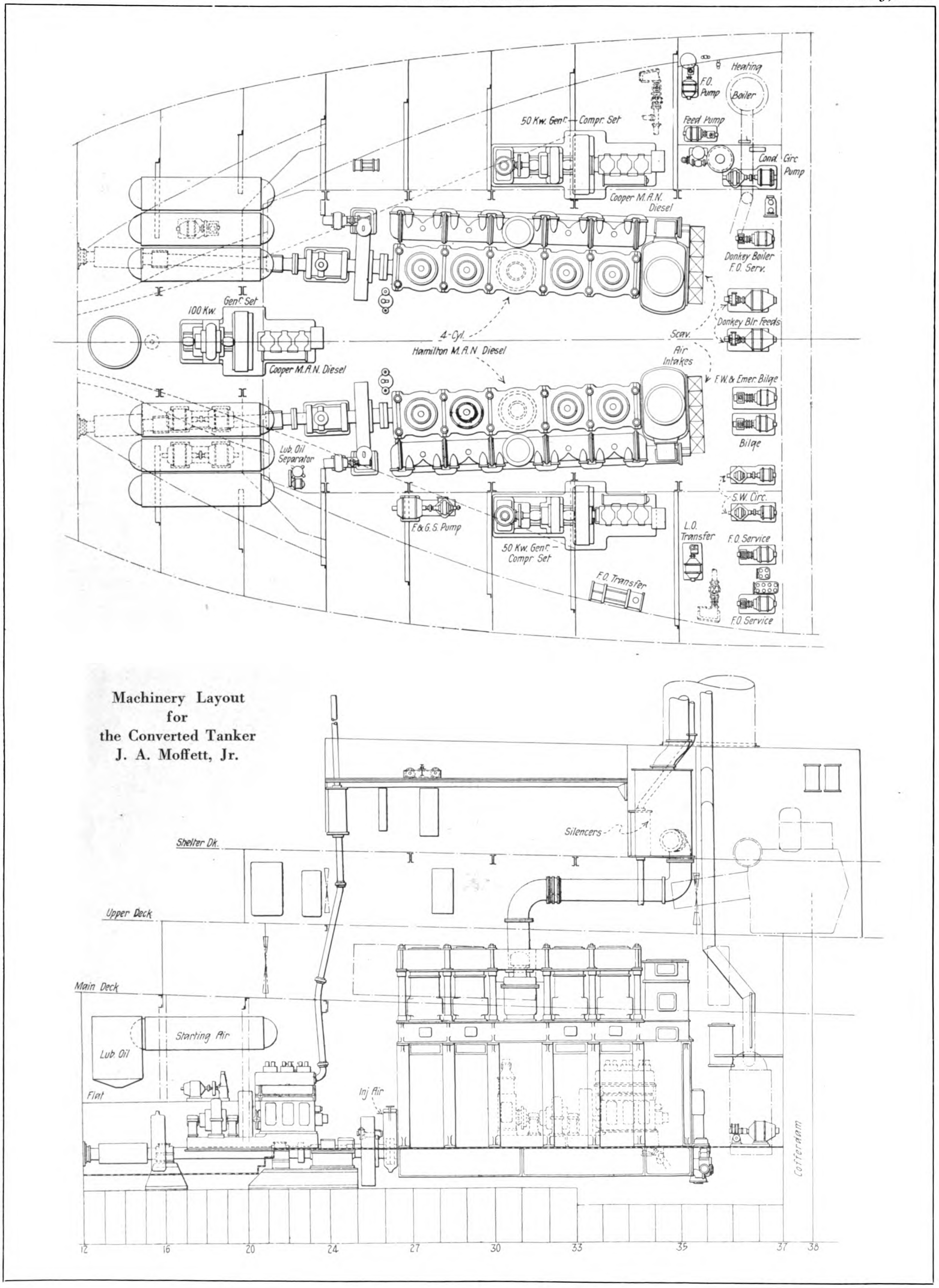
This lapse of time afforded an excellent opportunity to give each problem of conversion careful consideration, as well as for fabricating most of the steel work. The pump flat, for example, was set up in the shop with the pumps in place and piped up. Later it was put into the ship in sections.

One of the most important items in Diesel conversion is the main engine foundations. In fact it is not too much to say that the success of a conversion varies directly with the foundation. The foundation plan shows at transverse 33 a difference in the tank top heights of 24 in. It appeared at first that the tank top from tr. 33 aft would have to be lowered in order to clear the pan under the engines. It was then decided to do away with the pans and use the tank top and inside main engine girders for this purpose. Due to the height of these girders being only 12 in. something of permanent tightness had to be used and a tee bar with a plate double riveted and welded was used.

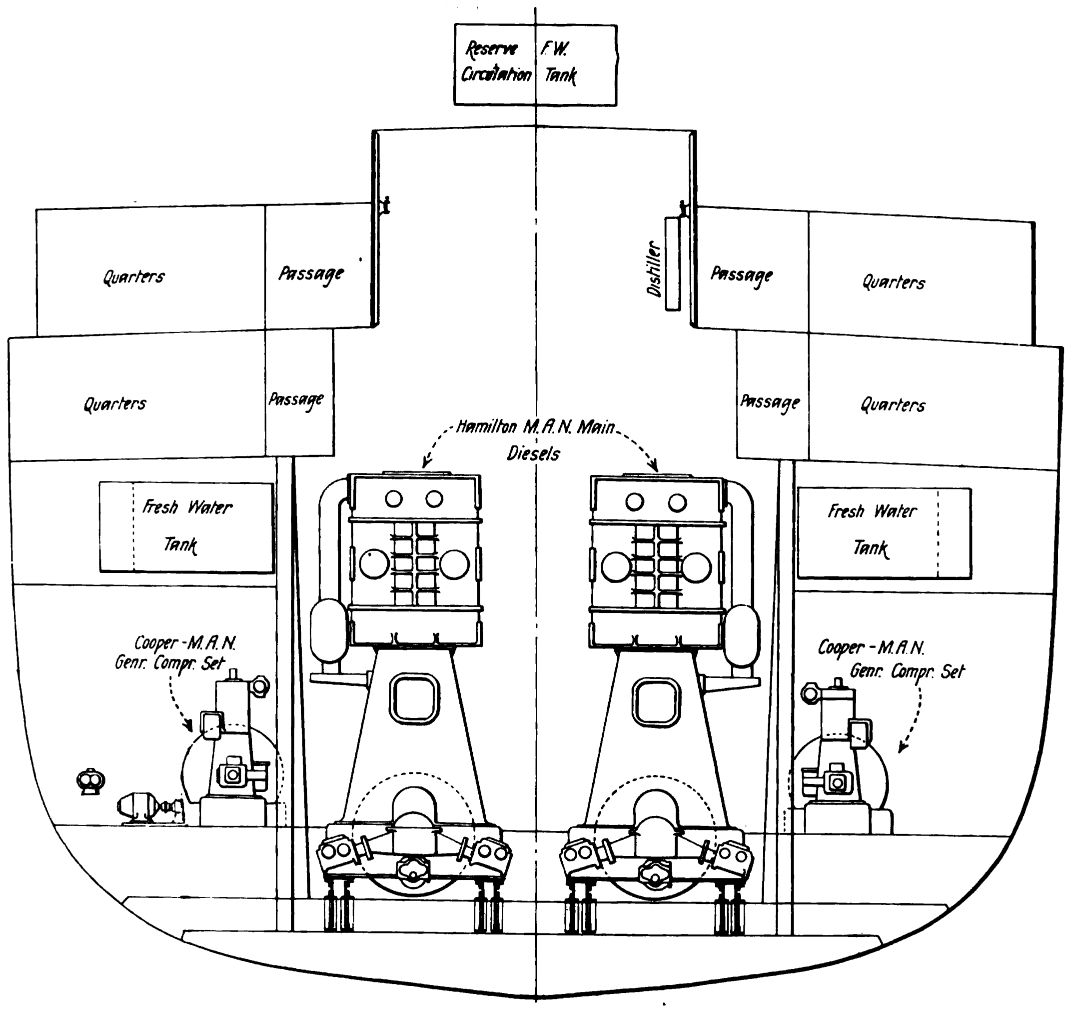
The tank top was then continued for-



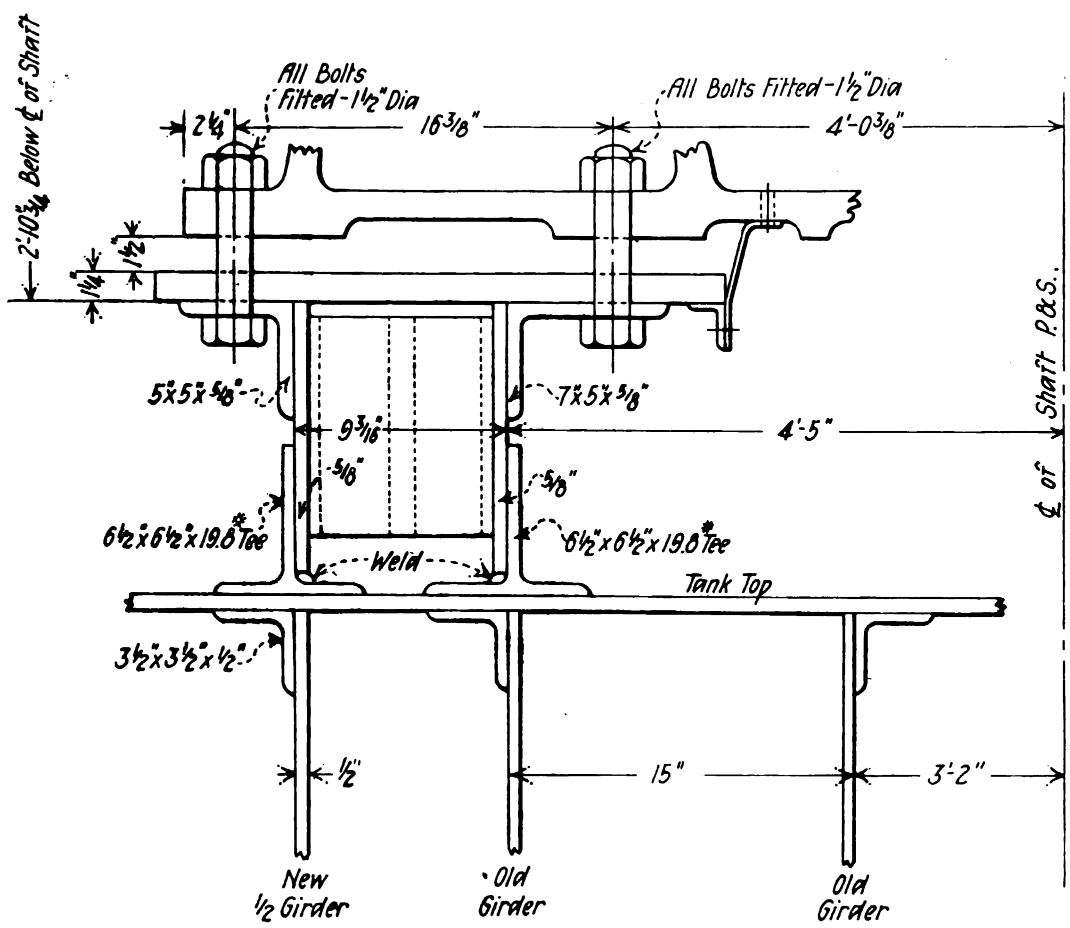
The success of a conversion varies directly as the design of the engine seatings. This shows structural details of the main engine seatings of the J. A. Moffett Jr. and indicates how the difference in tank depth at transverse 33 was overcome



Machinery Layout for the Converted Tanker J. A. Moffett, Jr.



Section through the machinery space of the tanker J. A. Moffett Jr.



Main engine girder and seating details showing new construction in way of tank top

ward from frame 33, and the sump tank built under, thus eliminating cutting down the tank top and weakening the existing construction.

Before proceeding with this work the entire tank top was removed and new floors and girders as shown on the sketch were installed. The brackets on the main engine and auxiliary sets form a girder from shell to shell giving extra rigidity which is so essential in Diesel engine foundations.

In the forward port corner of the engine room there was constructed a gas tight enclosure for the heating boiler. From the inboard side of this enclosure to the starboard side of the vessel is a continuous 15 in. channel on which is attached the pump foundations; this gives clear straight leads below for piping.

On the upper deck on the port side between transverses Nos. 33 and 37 an enclosure was constructed for the condenser compartment. The old condenser was shortened, reconditioned and located in this enclosure along with the old steam generator, and grease extractor. On the deck below is the filter box and condensate pump.

In the same space on the starboard side are enclosures for the fuel oil watch tanks and centrifuges and below these are located the fuel oil day tanks. A 4-panel General Electric Co. switchboard is located on the forward bulkhead in line with the lower engine grating.

Independent emergency lights have been provided both on the new switchboard and at main engine controls.

Due to the height of the scavenge pump on the main engine it was necessary to move the donkey boiler room forward. This was accomplished by cutting through the cofferdam and 5 ft. 6 in. into the cross bunker. A cofferdam was then constructed around the new boiler room.

The muffler enclosure was constructed just aft of the donkey boiler room in which are located the main engine and two auxiliary engine maxim silencers.

Reed air filters were built into a frame of 14 units each and connected directly to scavenging pump suctions on engine. This eliminated the scavenging trunks and suction silencers, and the installation has proved very effective.

All exhaust pipes are led from the silencers up the stack with spark arresters attached to them. This precaution is taken to eliminate sparks while vessel is lying at the refinery or loading stations. The stack is also used as a ventilator for the donkey boiler and muffler enclosures.

Two marine type watertube boilers fitted with Todd pressure fuel oil burning system are used for heating the cargo tanks and supplying steam for the cargo pumps, windlass, warping winch and winch located aft of pump house. The winch located aft of pump house operates derricks that handle the shore line connections.

The old steam steering gear was completely removed and replaced with a hydro-electric gear, linked up with a Sperry two-unit gyro equipment and the old telemotor, thus permitting the ship to be steered by the telemotor independently of the gyro.

The old emergency steering gear on the docking bridge aft was reconditioned and connected to new gear.

The old steam refrigerating plant was removed and replaced by a new electric

driven 2-ton ammonia compressor refrigerating unit.

A complete Lux fire extinguishing system was installed in all main cargo oil tanks, cofferdam, fuel oil tanks, dry cargo spaces, storerooms, pumproom, machinery space, donkey boiler space, day tank and watch tank rooms, heating boiler space, paint room and lamp locker.

A feature in the transportation of the engines which came from Hamilton, Ohio, via the Erie R.R. was the shipping of the main engine beds with the crank shafts in place on one car, a weight of 72 tons each.

The upper and lower entablatures were also shipped assembled, and lowered into the ship in place without being disassembled.

The main engine beds were also put in place without removing the crank shafts, and after being set were found to be in perfect alignment.

The Main Diesels of Ms. J. A. Moffett Jr.

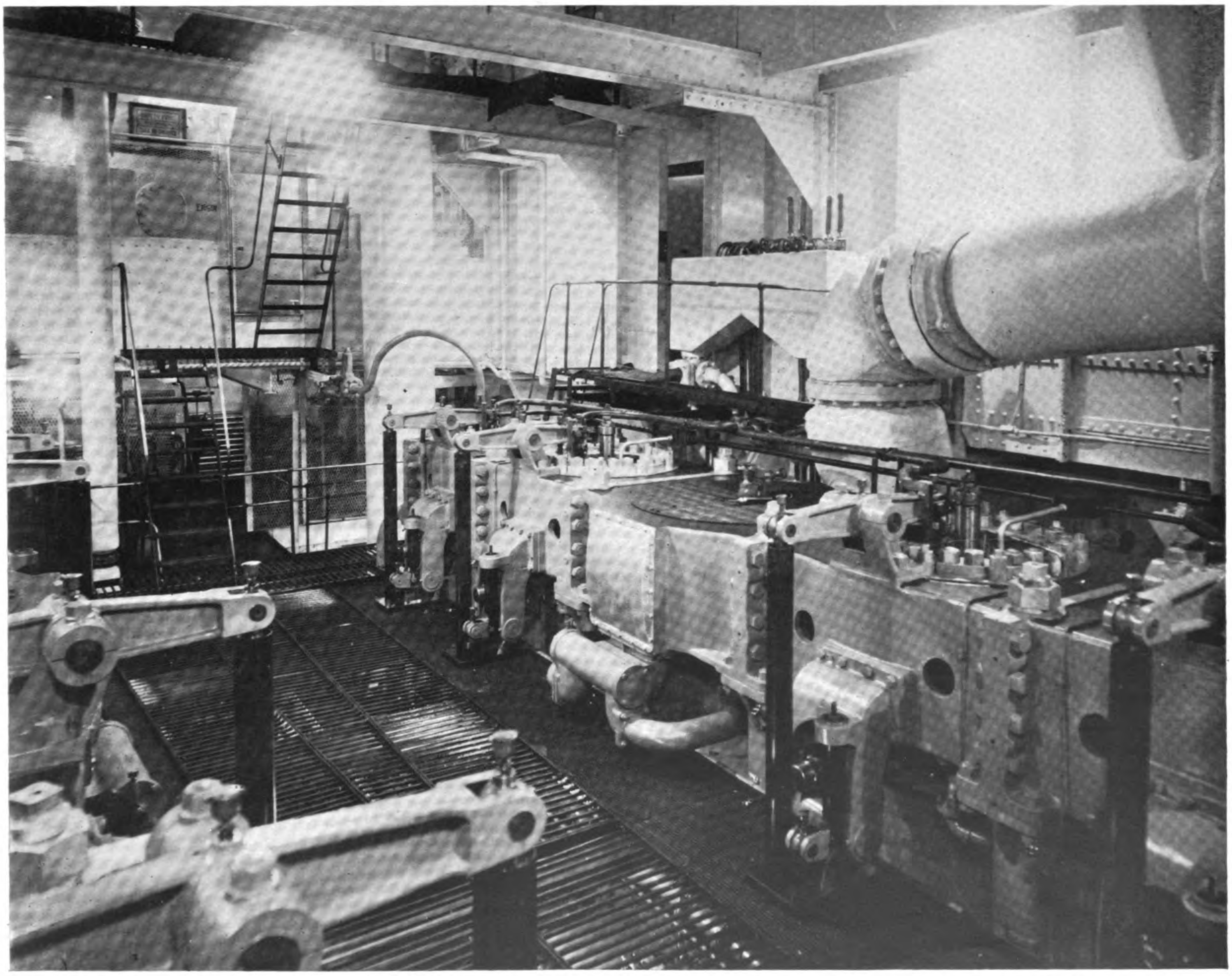
THE two main engines as has been mentioned are of Hamilton-M.A.N. type—one starboard and one port engine for the twin screw installation. The engines have four power cylinders with attached compressor and attached scavenging pump on each engine. The cylinders have a diameter of $27\frac{1}{2}$ in. with a stroke of $47\frac{1}{4}$ in.

Construction of the engine consists of the bedplate, and individual housings. On top of the housings there extends a heavy cast iron member in the form of the entablature to which the housings are bolted and which gives the fore and aft tie to the engine. On top of this lower entablature are set columns between the cylinders and the upper part of these columns are bolted to the upper entablature which is similar in construction to the lower and adds to the rigidity of the engine.

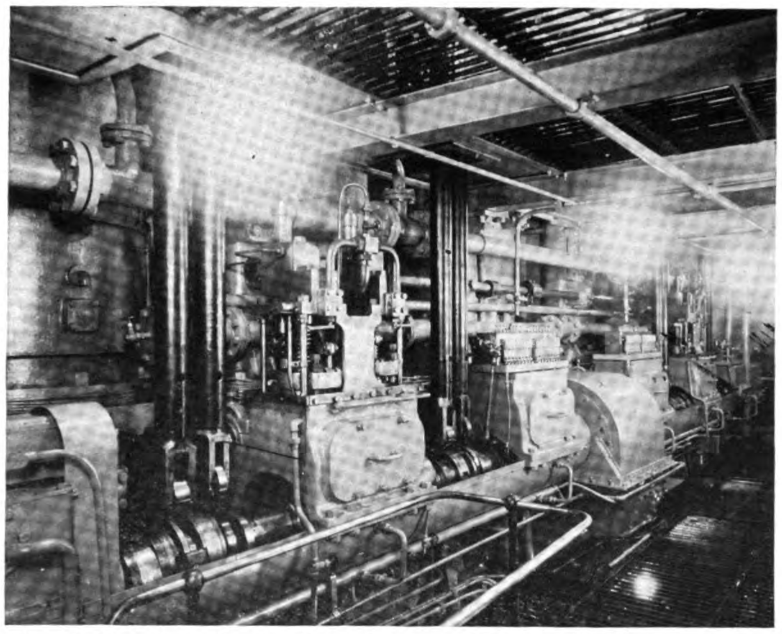
The cylinders are set independently between the columns and the cylinder jacket is bolted to the lower entablature whereas the cylinder liner is bolted to the upper entablature. In the recesses of the upper entablature are set the cylinder heads made in three parts, of steel casting. The cylinder heads on the combustion side are forced against the taper in the liner and the upper part of the cylinder head is bolted on top of the upper entablature and forces the cylinder head in place at the proper tension. This construction eliminates heavy cylinder bolting on the liner or cylinder itself.

For absorbing the combustion load, all tie rods are set in the columns and extend from the bottom of the bedplate to the upper part of the entablature. These bolts are set up with initial tension so as to relieve all cast iron parts of any tension load.

Each cylinder head has one fuel valve, one starting valve and one relief valve. The camshaft is located on the lower entablature on the operating side of the engine and is driven from the crank shaft through spur and bevel gears. The fuel pump has a novel arrangement in that it is driven from the camshaft by cams and there is one plunger for each fuel valve. The pump is so timed that it delivers fuel slightly ahead of the opening time of the fuel valve and only delivers a sufficient amount for each stroke. The starting valves are controlled from the camshaft at mid platform level.



Top platforms in engine room of Ms. J. S. Moffett Jr., showing the two main single-acting 2-cycle Hamilton-M.A.N. Diesels



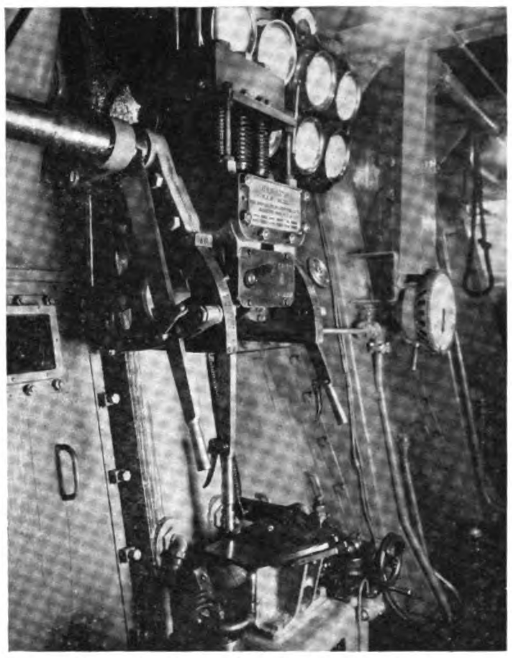
Camshaft and pushrods of starboard engine at mid platform level

Pump group in engine room shows compact nature of centrifugal units

The crosshead is of the single type slipper construction with the guide located in line with the piston rod. The piston is of steel and water cooled. All water is led to the piston through the center of the piston rod and returned in an outer circular passage. The inlet and outlet pipes to the piston rod are carried on the brackets attached to the crossheads and through telescopic piping. Water is all piped up to the fresh water system in the ship. The cylinder jackets and compressor are cooled by fresh water with a continuous system discharging from the cylinder jacket. The water is led through the exhaust piping giving complete water cooling to the exhaust piping attached to the engine.

The crankcase is entirely enclosed and all working parts are subject to forced lubrication. On account of the high pressures on the crosshead bearings, a separate pump is attached to the connecting rod and driven by the angularity of the connecting rod. This pump takes its suction from the lubricating system and delivers the oil directly to the crosshead pin bearings under a pressure in excess of 400 lb. This makes a very positive high pressure system individual pump being located on each connecting rod.

The compressor is of the 3-stage type and located in the middle of the engine. The air is cooled between each stage and water

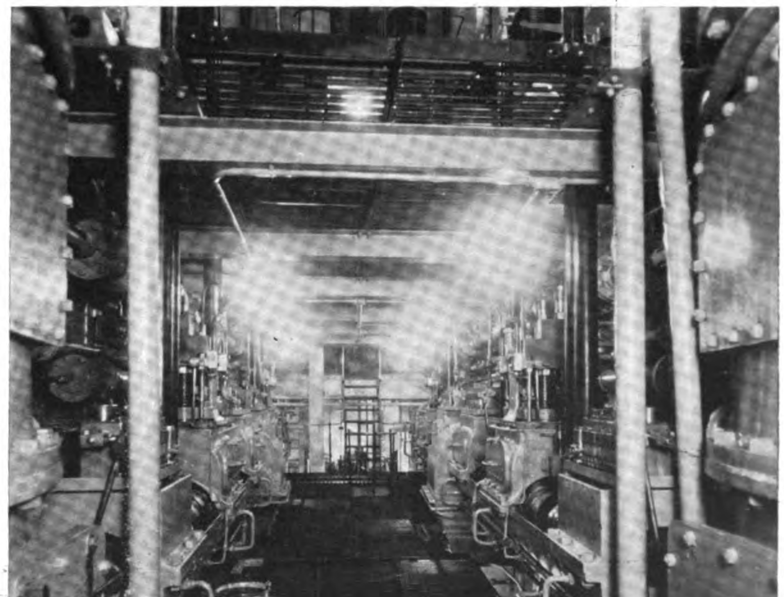


One of the main engine controls

separators are located below the coolers to extract the greatest amount of water from the air before passing on to the next stage. The air compressors are over-sized and so proportioned so that one compressor will be sufficient for supplying injection air for both engines. The scavenge pump is located at the forward end and is of the reciprocating double-acting type fitted with patented plate valves giving the greatest efficiency. One of the novel features of the scavenge pump is that air filters are located directly on the pump and all the air necessary for the scavenging is drawn directly from the engine room.

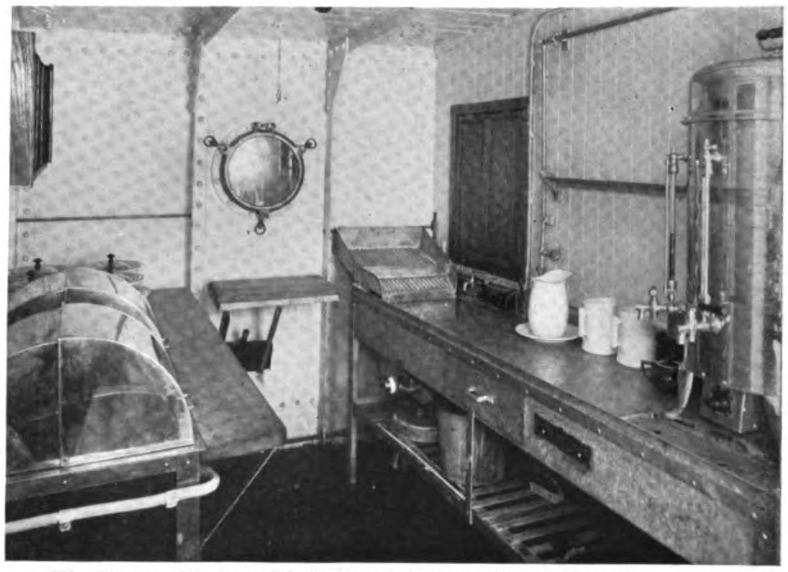
Similar filters are also placed on the inlet oil compressor. This eliminates large air ducts through the engine room to the top deck. The air filters not only eliminate dirty air from entering but also act as a silencer. Another novel feature on the engines is the attached pumps which are located at the forward end of the crank shaft and the pumps are set into a casing which gives easy access, substantial construction and simplified pipe lines. The pumps consist of the two water pumps—one for fresh water and one for salt water for the piston and cylinder cooling respectively. These

Controls between main engines on the bottom platform

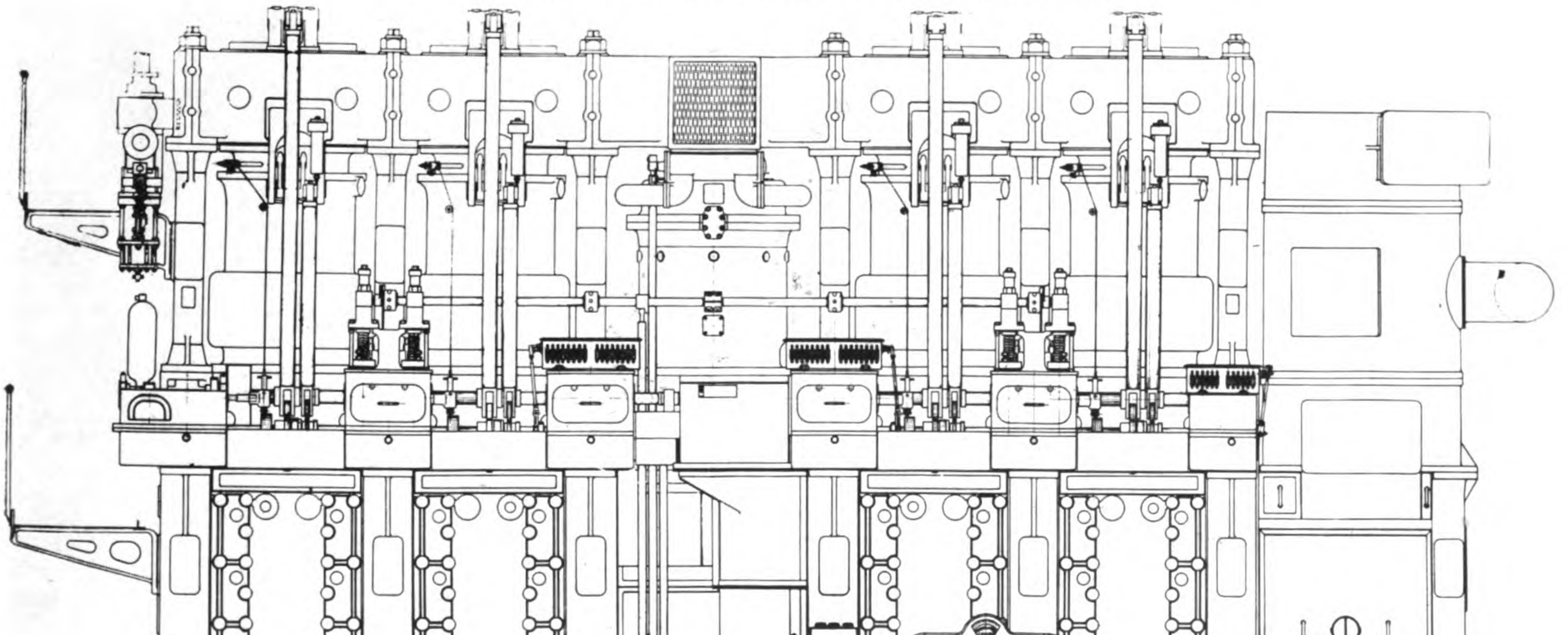


View of middle platform where the camshaft is located


One of the Cooper-M.A.N. generator-compressor sets


Electric cooking and heating units are featured in the pantry

Main engine beds were shipped with crankshafts in place


Ms. J. A. Moffett Jr.'s main engines are each 4-cylinder, single-acting, 2-cycle units, developing 1650 hp. at 90 r.p.m.

Equipment of Motortanker J. A. Moffett Jr., Converted by Tietjen & Lang D.D. Co., Hoboken, N. J., Engined by Hooven Owens Rentschler Co., Hamilton, Ohio

Name of Unit	No.	Description and Characteristics
Propelling Machinery		
Main engine	2	H. O. R. 1650, 2-cycle, single acting, 4 cylinders 27½ in. x 47¼ in. x 90 r. p. m.
Propeller	2	Doran-Slocum, manganese bronze, 4-bladed, built up, 15 ft. 0 in. diameter
Line shaft	2	T. & L., solid forged steel, 15 in. diameter.
Propeller shaft	2	T. & L., solid forged steel, 14½ in. diameter.
Thrust shaft	2	Single collar forged steel, 14⅜ in. diameter.
Boilers and Heaters		
Donkey boiler	2	Small water-tube, 250 lb. working pressure, 1591 sq. ft. heating surface.
Heating boiler	1	New, vertical, 100 lb. working pressure, 269 sq. ft. heating surface.
Feed water heater	1	136.4 sq. ft. heating surface, originally in ship.
Fuel oil heating boiler	1	Bethlehem, coil 44.8 sq. ft. heating surface, originally in ship.
Fuel oil burners	4	Todd Rotary 2 electric forced draft blowers.
Condensers and Coolers		
Condenser	1	Federal, steel plate type, 2,000 sq. ft. cooling surface, 15 in. vacuum at 85 deg. Fahr., original condenser modified.
Lubricating oil cooler	2	Straight tube, multiwhirl 2-pass, 75 gal. per min. each. Griscom Russell.
Drinking water set	1	Davis Engineering Co., 350 gal. per day.
Fresh water cooler	2	Straight tube, multiwhirl, single-pass, 65 gal. per min. each. Griscom Russell.
Compressors		
Main air compressor	2	3-stage attached to main engines, 560 cu. ft. free air per min. capacity, 1,000 lb. per sq. in. pressure.
Auxiliary compressor	2	M. A. N., attached to Diesel generator sets by magnetic clutch, 200 cu. ft. free air per min., 260 r.p.m., 1,000 lb. per sq. in.
Scavenge pump	2	Attached. Double acting, 7,650 cu. ft.
Emergency air compressor	1	2-stage motor driven, 1,000 lb. per sq. in., 8 cu. ft. free air per min. Worthington.
Pumps		
F. o. injection pumps	2	H. O. R., attached to main engines.
Lubricating oil pump	2	H. O. R., attached to main engines, 50 gal. per min.
F. w. cooling pump	2	H. O. R., attached to main engines, 70 gal. per min. at 30 lb. per sq. in.
S. w. cooling pump	2	H. O. R., attached to main engines, 400 gal per min. at 30 lb. per sq. in.
S. w. circ. pump	2	Worthington, centrifugal, motor driven, 500 gal. per min. at 30 lb. per sq. in., 15 hp. motor drive.
Fire and g. s. pump	1	Worthington, centrifugal 3-stage, motor driven, 200 gal. per min. at 125 lb. per sq. in., 40 hp. motor.
Condenser circ. pump	1	Worthington, centrifugal, motor driven, 1,000 gal. per min. at 30 ft. head, 15 hp. motor.
Bilge pump	2	Northern rotary, motor driven, 275 gal. per min. at 25 lb. per sq. in., 8½ hp. motor.
F. o. transfer pump (Diesel)	2	Northern rotary, motor driven, 50 gal. per min. at 100 lb. per sq. in., 8½ hp. motor.
Lubricating oil pump	1	Northern rotary, motor driven, 125 gal. per min. at 30 lb. per sq. in., 8½ hp. motor.
Donkey boiler feed pump	2	Northern rotary, motor driven, 100 gal. per min. at 230 lb. per sq. in., 25 hp. motor.
Donkey boiler f. o. pump	1	Northern rotary, motor driven, 50 gal. per min. at 100 lb. per. sq. in., 8½ hp. motor.
Heating boiler f. o. pump	1	Northern rotary, motor driven, 25 gal. per min. at 100 lb. per sq. in., 5 hp. motor.
Heating boiler feed pump	1	Northern rotary, motor driven, 30 gal. per min. at 125 lb. per sq. in., 5 hp. motor.
Donkey boiler reserve feed pump	1	Worthington, vertical simplex, 12 in. x 8 in. x 24 in., originally in ship.
Donkey boiler f. o. reserve pump	1	National Transit.
F. o. transfer pump	1	Worthington, horizontal duplex, 8 in. x 5 in. x 12 in., 125 gal. per min. at 250 lb. per sq. in., originally in ship.
Condensate pump	1	C. H. Wheeler, horizontal duplex, 6 in. x 7½ in. x 6 in., originally in ship.
Cargo oil pump	2	National Transit. 14 in x 20 in. x 16½ in. x 24 in., 3,000 bbl. per hr. at 250 lb. per sq. in. originally in ship.
Drainage pump	1	National Transit. vertical duplex, 314 gal. per min. at 3,000 lb. per sq. in.. originally in ship.
Drainage pump forward	1	Worthington. horizontal duplex. 8 in x 8 in. x 12 in., 354 gal. per min. at 75 lb. per sq. in., originally in ship.
Hand fire pump	1	Rumsey, double acting 6 in. x 5½ in., 50 gal. per min., originally in ship.
Hand drain pump ('tween decks)	1	Rumsey, double acting, 5 in. x 5½ in., 30 gal. per min., originally in ship.
Lubricating oil sampling pump	1	Rumsey, hand operated plunger, 2 in. diameter 9 in. stroke.
Air pump	2	C. H. Wheeler, radojet, 3½ in. suction, 3 in. discharge, 15 in. vacuum at 85 deg. Fahr., originally in ship.
Fresh water pump	1	Horizontal duplex, 4½ in. x 2¾ in. x 4 in.
Auxiliary Electrical Generators		
Generator-compressor set	2	50 kw., 220 volt generator, 150 b.hp. Cooper M. A. N. Engines.
Generator set	1	100 kw., 220 volt generator, 150 b.hp. Cooper M. A. N. Engines.
Emergency generator set	1	20 kw., 110-115 volt, General Electric generator, steam prime mover.
Dynamotor	2	General Electric 15 kw., 220-110 volt.
Tanks		
Lubricating oil settling tank	1	T. & L., steel plate cylindrical, 1250 gal. capacity.
Lubricating oil storage tank	2	T. & L., steel plate cylindrical, 1200 gal. each.
Lubricating oil drain tank	2	T. & L., steel plate, 1000 gal. each, built into ship.
Diesel oil watch tank	2	T. & L., steel plate, 900 gal. each.
Fuel oil day tank	2	T. & L., steel plate, 2,700 gal. each.
Compressor oil tank	1	T. & L., steel plate, 400 gal.
Cylinder oil tank	1	T. & L., steel plate, 400 gal.
Reserve circ. water tank	1	T. & L., steel plate, 1,500 gal.
Maneuvering air tank	6	39 in. diameter x 13 ft. 0 in. long, 125 cu. ft. each.
Injection air tank	2	15¾ in. diameter x 5 ft. 9 in. long, 8 cu. ft. each.
Surge and whistle tank	1	T. & L., steel plate, 250 lb. working pressure, 3½ cu. ft. capacity.
Miscellaneous		
Steering engine	1	Hyde, hydro-electric, connected with Sperry two-unit gyro pilot equipment.
Gyro equipment	1	Sperry two-unit outfit with connection to steering engine.
Ice machine	1	Brunswick, ammonia type, motor driven, 2 tons per day.
Radio compass	1	In chart room.
Main engine silencer	2	Maxim, steel plate, 26 in. diameter.
Generator-compressor engine silencer	2	Maxim, steel plate, 6 in. diameter.
Generator engine silencer	1	Maxim, steel plate, 6 in.
Fire extinguishing system	—	Lux, CO_2, 118 cyls. of 50 lb. capacity.
Main engine lubricators	—	Manzell.
Signal whistle	1	Tyfon, compressed air, 8 in. diameter, 250 lb. working pressure.
Fuel oil purifier	2	Sharples, centrifugal, motor driven.
Lubricating oil purifier	1	Sharples, centrifugal, motor driven.
Circ. water strainer	1	Andale, 6 in., duplex, 1,000 gal. per min.
Donkey boiler f. o. suction strainer	1	Andale, 2 in., duplex.
F. o. discharge to watch tanks	1	Andale, 2 in., duplex, 50 gal. per min.
Piston cooling f. w. strainer	1	Andale, 3 in., duplex, 70 gal. per min.
Air filters	28	Reed 600 cu. ft. capacity each.
Pneumercators	2	Pneumercator Co.

pumps are made entirely of bronze construction and the lubricating oil pump is of the rotary type driven from the shaft through gearing. These pumps will take care of the engine at sea and eliminate the operation of independent pumps, which, of course, add to the efficiency and dependability of the engine.

The control station is located between the engines, each engine having individual controls for stopping, starting and reversing. The handling of the engine is accomplished by one lever which moves on a quadrant and accomplishes in step, reversing, starting and putting the engine on fuel. The control to the main starting valve, reversing engine is done through high pressure air oil cylinders. The speed of the engine is controlled by the by-passing of the fuel pumps. This is handled by a special lever and the controlling of the amount of air for the compressor is by a lever throttling the amount of air. An Aspinall overspeed governor is attached.

G. A. Rentschler, Jr. (right) and H. Greger, of Hooven, Owens, Rentschler Co., on trial trip

MS. J. A. MOFFETT JR.'s maiden voyage was from New York to Corpus Christi, Texas and back. On this trip she functioned perfectly. We hope to give details of the operation of her propelling machinery in an early issue.

A New Auxiliary Marine Diesel Engine

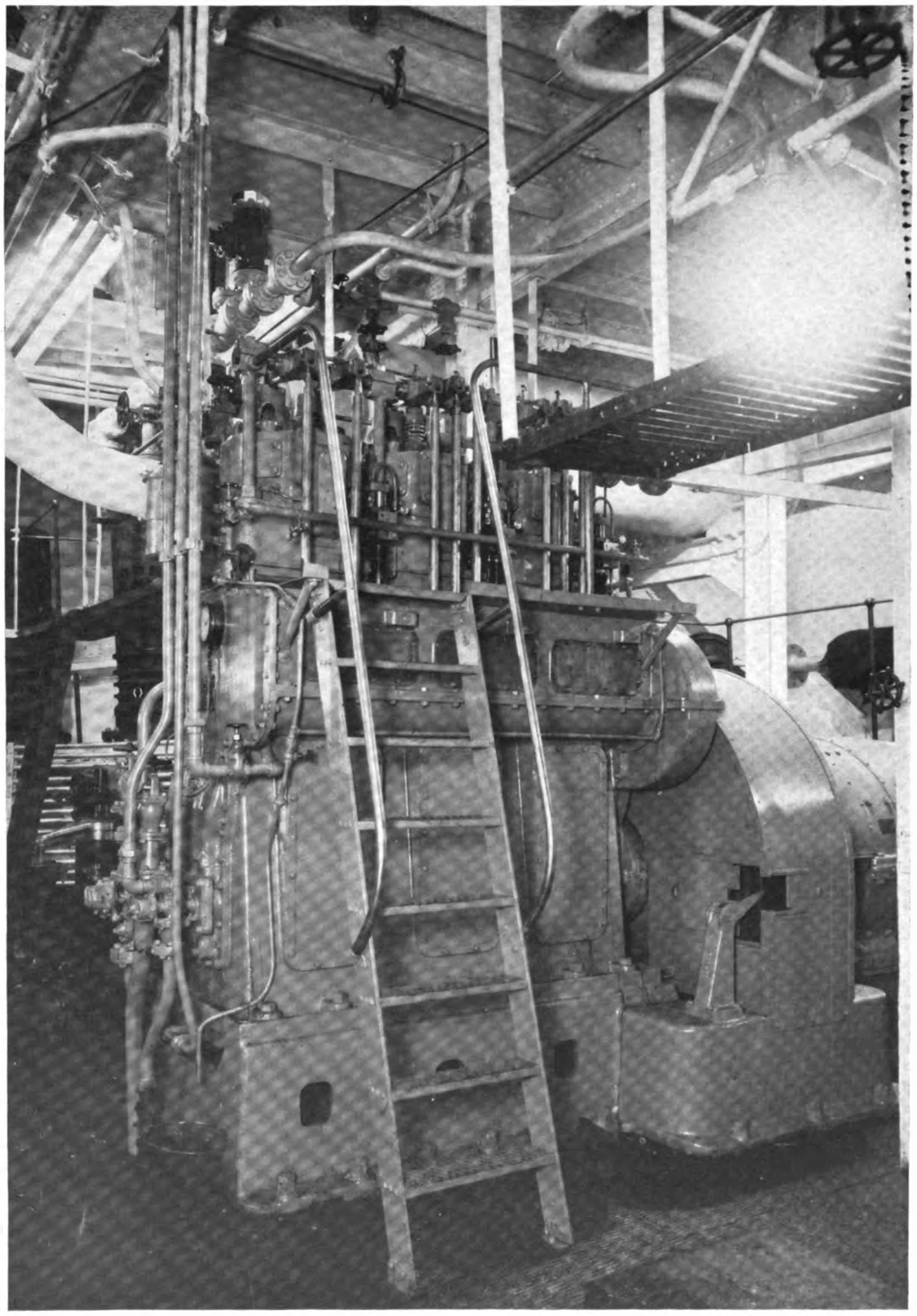
Airless Injection 4-Cycle Unit Is Now Ready for Installation on Modern Ships for Generator-Compressor Duties

THE three auxiliaries on the converted tanker J. A. MOFFETT JR. are of Cooper-M.A.N. design built by the C. & G. Cooper Co., Mount Vernon, Ohio. Each engine is a 3 cylinder unit having 12 in. cylinder diameter and 18 in. stroke developing 150 hp. at 260 r.p.m. The Cooper-M.A.N. engine is now definitely being marketed for marine auxiliary purposes and it is in many ways a note-worthy engine.

For the present, the manufacturers —we understand — will limit themselves to two cylinder sizes —building each in three, four and six cylinder units with a power range from 150 b.hp. to 800 b.hp.

This smaller type has a bore of 12 inches and a stroke of 18 inches and covers a power range of from 150-170 hp. in three cylinders, 200-225 hp. in four cylinders and 300-335 hp. in six cylinders at a speed ranging from 260 to 300 r.p.m.

The engine employs a one-piece construction of the bedplate, and thus with the enbloc construction of cylinders gives the most rigid form possible, and the presence of an outboard bearing between the flywheel and generator provides stiffness to prevent all whipping of the wheel and generator shaft. Through tie rods hold the cylinder block firmly to the bedplate and transmit the load directly to the main bearing anchors, and extensions of these bolts form the supports for all the rocker arm assemblies.



This is the 150 hp. Cooper-M.A.N. auxiliary Diesel attached to a 100 kw. generator set

The camcase is a part of the bedplate, and the camshaft bearings are very firmly ribbed to the main frame. The idler gear, which connects the crankshaft gear and camshaft gear, is anchored to the bedplate, thereby preventing any movement which would tend to alter the gear adjustment or cause them to be noisy. Fuel pumps are bolted directly to the cylinder block, as is also the governor shaft, this construction giving a maximum rigidity to the sensitive fuel cut-off mechanism and therefore permitting the best load regulation. Push rods are made of seamless steel tubing and are considerably stronger than usual, being 1½ in. outside diameter. The exhaust header is bolted directly to the cylinder heads, but by tap bolts so that any individual head may be removed without disturbing the header.

The bedplate is of a box frame construction, being in one piece from the foundation to the cylinder block. It carries the main bearings and camshaft bearings, and acts as an oil tight crankcase and camcase. There is a main bearing located on each side of each crank, and the bearing next to the wheel acts also as an alignment bearing, being able to take some end thrust. Main and crank bearings are constructed with removable shells, made of forged steel with babbitt lining. Any main bearing shell may be removed without disturbing the crankshaft. All parts of the crankcase are very accessible, since a 12½ in. x 31 in. door is located between each pair of main bearing anchors and tierods, are fitted with a small handhole and cover. The two ends of the bedplate are identical, making it interchangeable for right and left hand engines.

The crankshaft is a forging, with cranks set at 120 deg. for the three and six cylinder engines and 180 deg. for four cylinders. It is remarkably strong for this size engine, being 7½ in. diameter for both main and crank journals.

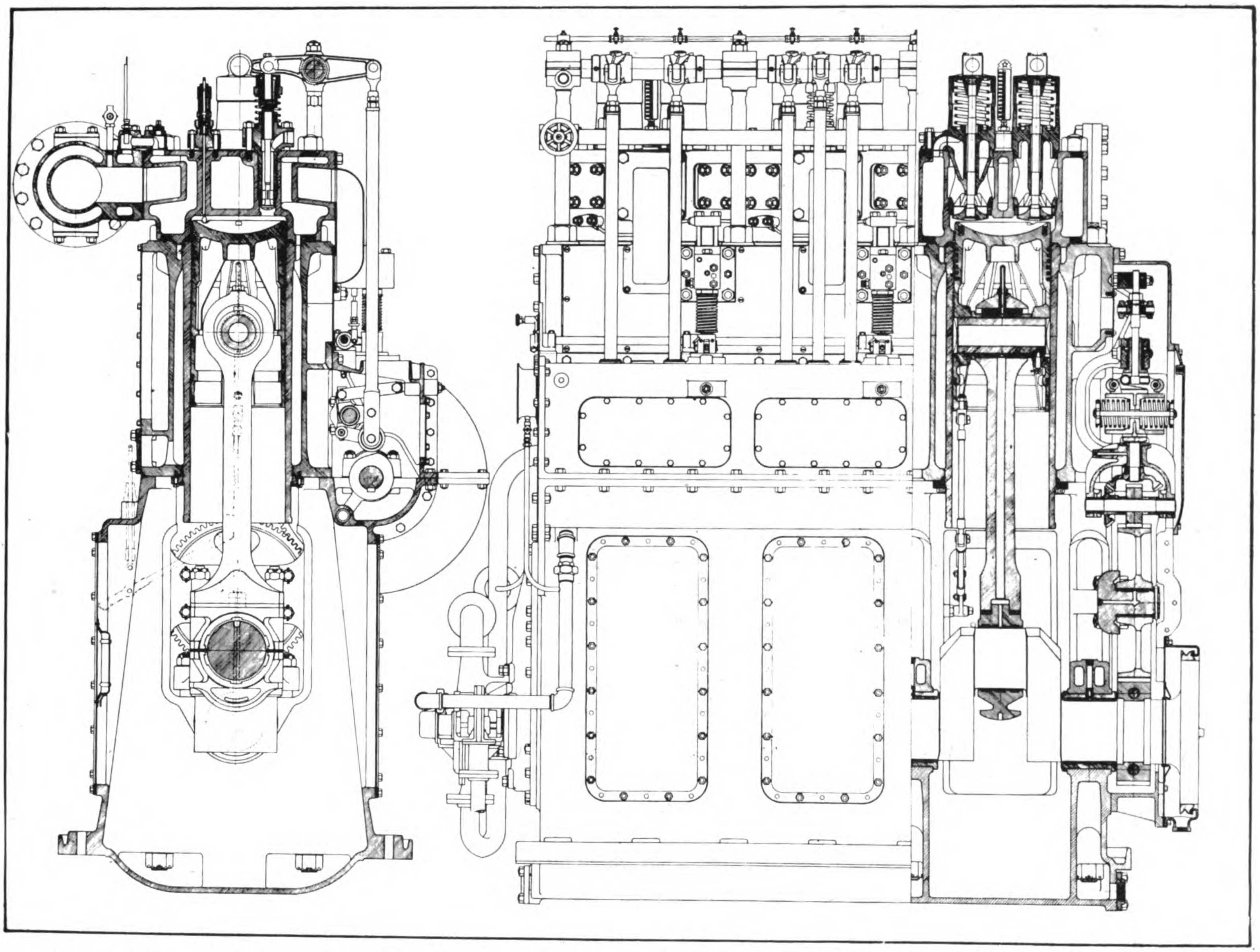
The shaft is drilled on an angle through each web, to deliver lubricating oil from the main bearings to the crank bearings. The flywheel is not keyed to the shaft in the ordinary manner, but is solid through its hub, a boss centering itself into a recess in the end of the shaft. The shaft is flanged, and ten very heavy through bolts connect it

to the wheel and to the driven shaft. These bolts may be removed without disturbing the wheel, as it is still held to the crankshaft by three separate tapbolts. The flywheel end of the shaft is fitted with an efficient oil thrower, so that there is absolutely no point where oil can escape and run over the outside of the engine. Except in cases where weight must be kept to a minimum, all engines are supplied with a flywheel of sufficient $K^2\omega$ to permit the parallel operation of alternators with a fluctuation of not more than three electrical degrees.

The cylinder block construction is made in one piece for three and four cylinders and two pieces for six cylinders, being inter-changeable for either right or left hand engines, the same as the bedplate. There are several advantages to building the cylinders enbloc. It forms the most rigid construction possible and elminates movement of cylinders with reference to the bedplate and to each other, thereby preventing misalignment which is injurious to crank bearings. This construction also forms an air intake silencer, since the intake air is drawn through the block, between cylinders; this provides a large quantity of air in storage for each cylinder at all times, so that no cylinder is required to suddenly start and stop a long column of air in a duct. When desired, the intake air may be taken from the outside, through a duct connected to the block, which still retains this advantage. This also forms a good, solid footing for the fuel pumps which could not be easily had with any other construction. This block is fitted with cast iron liners, the top joint of which is sealed by pressure from the cylinder head studs, and the lower joint by a packing gland and gasket. Therefore, although the cylinder block is in one piece, any trouble with a cylinder would necessitate replacing the liner only. The recess in the end of the block is common to both ends, since it may be used on either a right or left hand engine. This recess forms the governor housing, as will be seen from the cross section, thereby conserving a great deal of space as well as forming ample protection to the governor. The governor is still very accessible, however, for by removing the cover plate the operator may remove the springs and weights if necessary.

The construction of the heads is rugged and simple. This design is not considerably changed from that of the original M.A.N. head, and therefore has been very thoroughly tested against breakage. The water path through the head is such that the highest velocity is attained at the hottest sections, and each section receives its share of water because a short-circuit is impossible. The water from the heads also passes through the exhaust valve cages it should be noted.

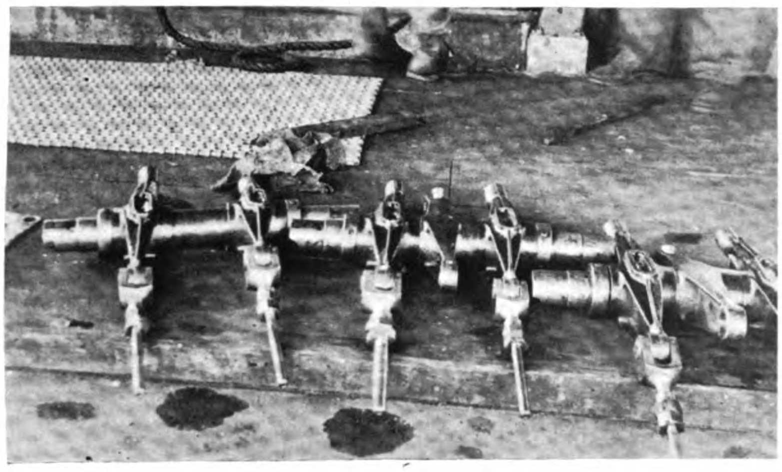
Pistons are of close grained cast iron, with dished heads and heavily ribbed from the head to the piston wall. A special arrangement of rings gives an unusually low lubricating oil consumption. Connecting rods are of the marine type, forged round, with 4½ in. wrist pin bearings and 7½ in. crank bearings. A piston may be removed without disturbing its crank bearing, or the piston may be locked in its top position and its bearing removed. The compression pressure is controlled by the thickness of a plate between the end of the connecting rod and the crank bearing, and is set at 400 lb. when the engine leaves the shop. However, it is easily changed, should the customer wish.



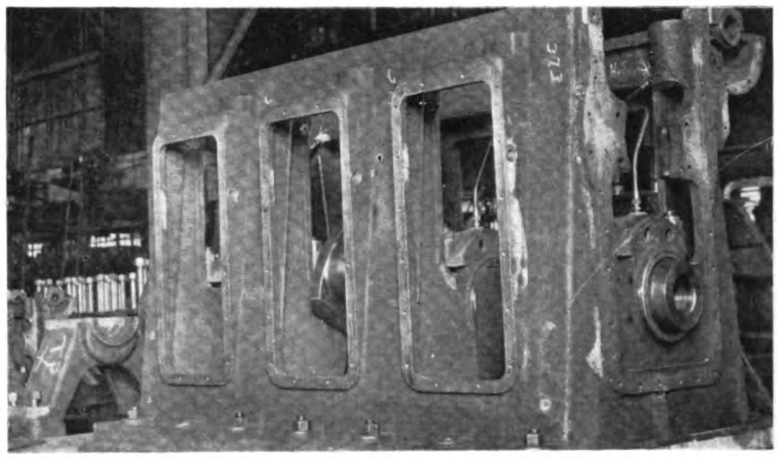
Shows ruggedness of design and simplicity of construction of the Cooper-M.A.N. auxiliary Diesel set developing 150 hp. at 260 r.p.m.

The inlet and exhaust valves are of cast iron, screwed on to steel stems. The valves are 4½ in. diameter and give practically no back pressure, as shown by low pressure stop cards. The valve springs are enclosed, as is usual Cooper practice. All valves have removable seats. The air starting valve roller is put into contact with its cam only when the pressure is admitted to the header.

The rocker arms are very accessible and may be lifted off, completely assembled. One end of the rocker arm is cylindrical and projects into a bronze bearing in the top of the valve stem guide, while the other is



Rocker arm assemblies lifted off



Box frame and bedplate in one piece

connected to a shackle, the lower end of which slides into the hollow push rod. Therefore, by removing two nuts, the entire assembly for any one cylinder may be lifted off by hand. The roller clearance is adjusted by nuts on these shackles. All rocker arms, guide links, rollers, etc., are bronze bushed.

All cams, except the fuel pump cam, are chilled cast iron and of a special Cooper design which produces unusually quiet action. The camshaft drive is through spur gears—a pinion on the crankshaft, a gear on the camshaft, and an intermediate gear. This intermediate gear is provided with an adjustment that may be changed should the gears become noisy through wear. The large gear has a very heavy rim and acts as a flywheel to the camshaft.

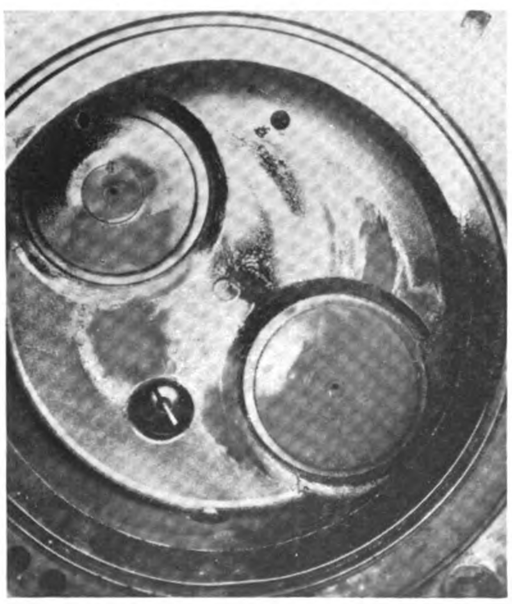
All pumps are of the rotary, positive displacement type, driven directly from the crankshaft. Various combinations of pumps may be used depending on the conditions under which the engine is to be run. The engine has lubricating oil and water circulation pumps geared to the end of the crankshaft.

The injection system is a variation from common practice and the change seems to have been justified. Inspection of piston tops after more than a year's operation on an industrial load, and the same after the usual 100 hour marine auxiliary tests, show the original tool marks as plainly as do new pistons. At no time yet have rings shown the slightest signs of sticking, and under 80 lb. brake mean pressure the exhaust is colorless. These conditions, together with the fact that the engine will start on the first revolution on 400 lb. compression when the cylinder block is considerably below freezing temperature, indicate that combustion conditions are almost perfect.

The fuel is delivered first to the filters on the front of the engine, then to the injection pumps. These filters are made from very fine mesh monel metal cloth and are arranged so that the feed can be changed from one filter to the other, without interfering with operation. The fuel pump itself is not greatly changed from the original M.A.N., except in detail. These details were changed more for the purpose of making it a better manufacturing proposition than anything else, and did not alter the principle of the pump. This pump has two discharge valves, the second of which is heavily spring loaded. Since fuel oil is slightly compressible, a very small part of the stroke of the main plunger is used in building up quite a pressure, so that the fuel is under this pressure before it starts through the lines leading to the nozzles. It then builds up a still higher pressure (6,000 lb. by actual measurements) due to the increased velocity of the plunger, which is very suddenly released and reduced to atmosphere by a quick opening balanced by-pass. This point of "cut-off" is of course controlled by the governor.

The timing of the injection may be varied while the engine is running, and is done by rolling the fuel pump roller around its cam. This adjustment is made from outside the camcase. There is no clearance between this roller and its cam, it being always in contact.

There are two horizontal nozzles to each cylinder, each containing but two jets. Neither of these nozzles has check valves or other moving parts. They are unnecessary with this construction of fuel pump. These nozzles are not opposed, but their jets are directed tangent to an imaginary circle in the center of the combustion space; and since the combustion space is perfectly round and symmetrical, a twisting "windstorm" is produced which cannot but produce a desirable effect. There is also another very important advantage to this type of injection when it is analyzed: The distance which a jet will penetrate depends not only upon the pressure and wall thickness but also upon the hole diameter, the penetration being almost proportioned to the diameter. Therefore, since with this method of injection the distance to be penetrated is practically twice that of center injection, the holes can be proportionally larger, which almost entirely frees them of clogging with dirt and carbon.



Interior of cylinder head after long operating period

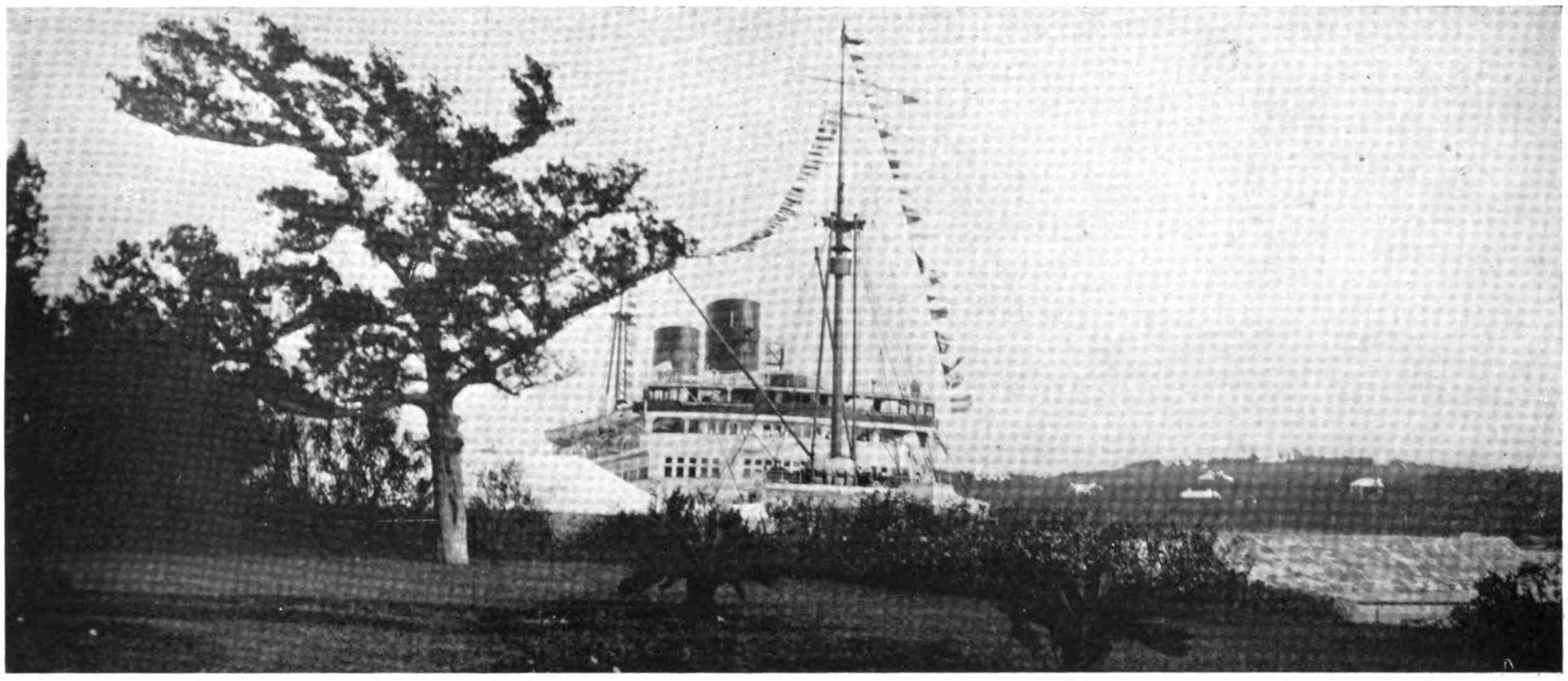
The by-pass operating shaft is connected to the governor through a coiled spring, and carries a hand lever on its opposite end, so that the engine may be controlled by hand independently of the governor if desired. The end of this hand lever is pointed and indicates on a graduated scale the percentage load on the engine at all times. It is graduated from zero to 150 per cent. The governor is unusually sensitive and gives very close speed regulation. Starting and stopping may be done either from the gallery or from the floor, depending on the arrangement desired. Provision is made for heating all fuel filters, pumps, and pipes by jacket water or steam, if it is desired to burn viscous fuels.

The lubrication is by pressure feed to all moving parts, there being no hand oiling on the engine. The rotary pump delivers oil to a $1\frac{1}{4}$ in. pipe, which runs parallel to the camshaft and is cast in the bedpate. Oil is then led by short pipes to the main bearings, through the drilled crankshaft to the connecting rod bearings and through the connecting rods to the wrist pins. Holes drilled in the main casting lead oil to the camshaft bearings, from which it overflows into the camcase where the cams constantly dip into it. A separate $\frac{3}{8}$ in. line inside the camcase feeds branches to all guide links, rollers, rocker arms, and the governor. Lubrication of the pistons is by splash only and of course is ample for this size cylinder.

The C. & G. Cooper Company plans to build certain definite sizes up to 1000 H.P. on a quantity production basis, in much the same manner as they have done with steam engines and gas engines and compressors in years past. They have a large and modernly equipped manufacturing plant where they have been building heavy machinery of one kind or another for 94 years.

The Oertz Streamline Rudder Corp., of 75 West St., New York City, advises us that the entire new building program for eleven ships, recently released by the North German Lloyd, will be fitted with Oertz rudders. They report a present total world tonnage of 1,286,000 dw. tons, 244 vessels.

Standard Motor Construction Co., Jersey City, N. J., is to re-engine two Socony tankers.



Motorliner Bermuda Enters Service

Power Plant of New Motorliner Bermuda Proves Feasibility of Motorship for Short, High Speed, Runs with Quick Turnaround

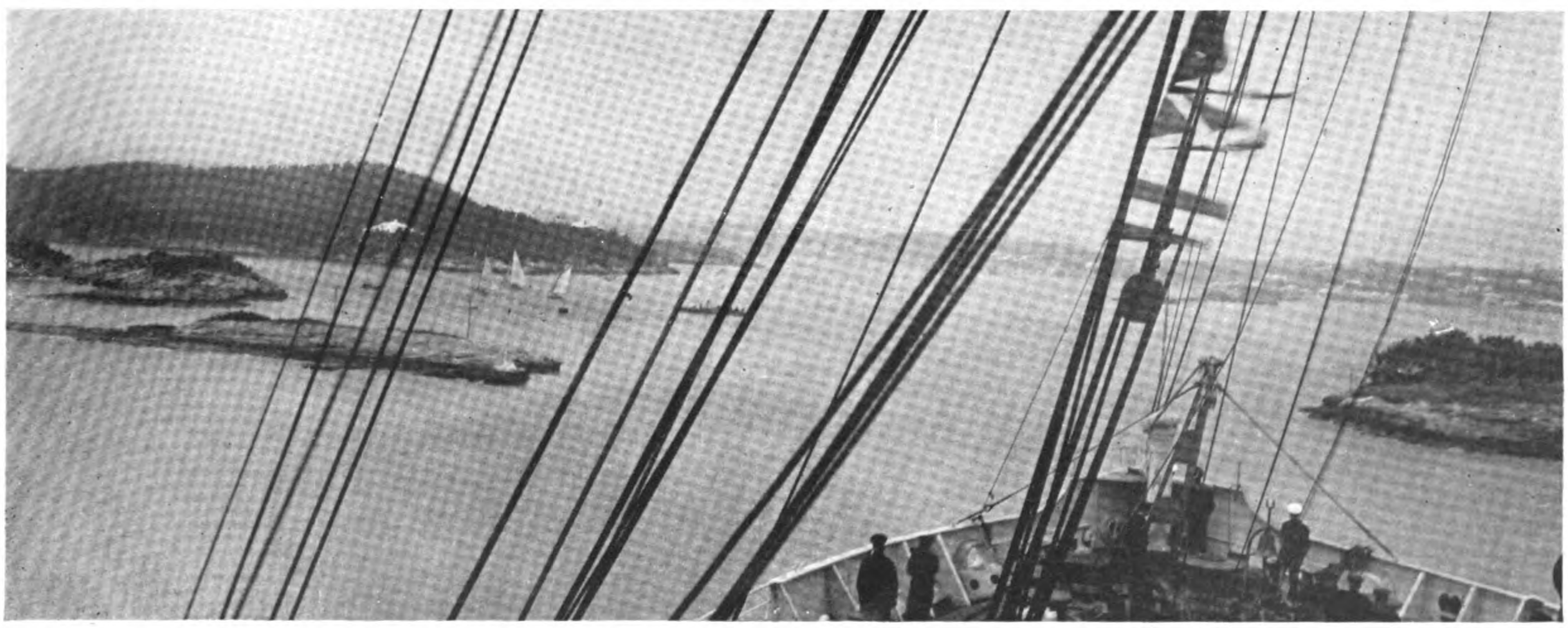
FOR years MOTORSHIP has advocated Diesel drive for big ocean-going passenger liners, and now it seems that there is a distinct trend on the part of shipowners to add new tonnage of this type to their fleets. The motorliner BERMUDA is one of the latest and best examples. Many will find irony in the fact, however, that although this motorship will carry mainly American citizens from and to an American port she is owned in London. MS. BERMUDA is unquestionably a noteworthy motorship, and on her maiden trip functioned perfectly. Aside from the remarkable economy of operation, the very smooth running, absolute lack of vibration and absence of soot and clinkers on deck were continuously commented on by all the passengers, particularly by old sea travellers.

We propose to confine what follows mainly to a description of the BERMUDA'S machinery. This is the third article on the ship we have published to date. The first, in our November issue, described the passenger accommodation and layout. The second, in January, 1928, compared the vessel with the motorliners AORANGI and GRIPSHOLM and discussed her general features and machinery layout.

Characteristics of Ms. Bermuda

Length b.p.	550 ft. 0 in.
Beam mld.	74 ft. 0 in.
Depth mld.	45 ft. 0 in.
Gross tonnage	17,000 tons
Total power	11,200 b.hp.
Speed of engines	110 r.p.m.
No. of screws	4
No. of passengers	691

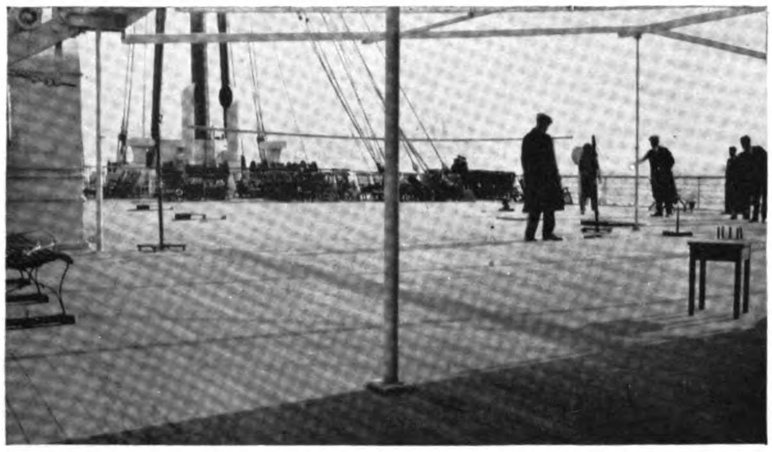
As this is being written the vessel is completing her maiden round trip from New York to Bermuda. The voyage was in every way satisfactory. When in the dining saloon or in the lounge it was hardly possible to tell that the engines were running. Only in one place—the Verandah Café aft, was it possible to detect any tremor whatever, and that may have been due to the four propellers pounding the water under the cruiser type stern. Even this was slight and not uncomfortable. In fact, never were we on a passenger ship that ran so quietly and was so free from vibration. The four Doxford main Diesel engines and four Fiat Diesel auxiliaries ran with a perfectly clear exhaust during the entire time and man-



Ms. Bermuda, 17,000 tons, the largest vessel to enter the narrow and tortuous channel to Hamilton capital of the islands, nosing her way to dock

Hotel-like Comfort on the New Motorliner Bermuda

One of the most noteworthy features of the new motorliner Bermuda, apart from the general luxuriousness of her appointments, is the vast galleried public hall on A deck extending up through the Sun Deck. In common with the rest of the ship this hall is absolutely vibrationless when when the ship is running. Accommodation such as the above will make the ship invaluable for world cruising



Ms. Bermuda is characterized by her large clear recreation deck—possible because she is a motorship

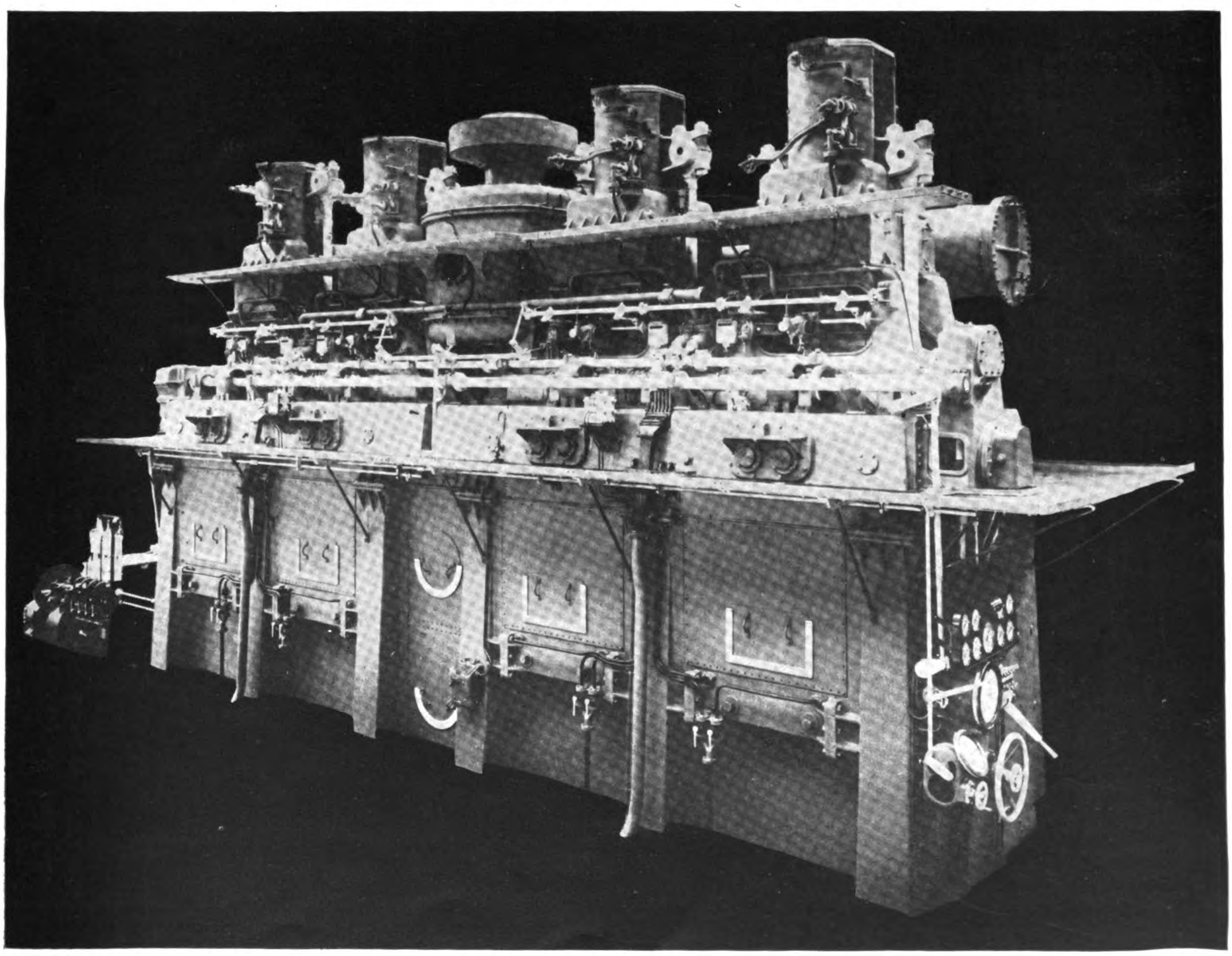
Clarity of the exhaust is seen in this picture taken on the maiden outward trip to Bermuda

euvered very smoothly and quickly. The vessel docked at Bermuda with the aid of but one tug and passed through the Islands with their very narrow channels without any tugs, both coming in and going out. This is clearly illustrated by the photo-praphs.

Officials of the Furness Bermuda Line on board expressed themselves as highly pleased with the operation of the ship. The run, of course, is only 666 miles each way so it was not practical to make the full speed of 17 knots of the ship as she would arrive before daylight and too early to dock. The run from noon on the day of sailing to ncon next day was 373 nautical miles at an average speed of 15½ knots with a moderate gale blowing. For the same period on the return voyage the ship logged 368 nautical miles.

The vessel arrived in New York at ebb tide and only three tugs were used in docking although she is of 17,000 tons gross.

The propelling machinery of novel nature, as far as a passener ship is concerned, consists of four sets of 4-cylinder Doxford opposed piston Diesels with 23⅝ in. diameter and 41 in. 30 in. strokes rated collectively for 11,200 b.hp. at 110 r.p.m. fitted in the main machinery room. Four Diesel driven generating sets are fitted in the auxiliary engine room, separated from the main engine room by a watertight bulkhead. In the auxiliary engine room two donkey boilers are fitted for generating steam for heating fuel. Auxiliaries are electrically



Four of these 6-cylinder, specially designed, opposed piston Doxford Diesels, form the main power plant of the new Furness Bermuda liner

driven, as are also the steering gear, capstans, windlass and winches. There is also a complete outfit of electrical cooking apparatus in the galleys.

Correct and economical navigation of the ship is materially aided by means of a Sperry gyro compass and repeaters located in the pilot house and in other key positions on the ship.

There are in all seven decks devoted to passenger accommodation including an exceptionally high promenade deck and dining saloon. A total of 616 first class and 75 second class passengers can be carried.

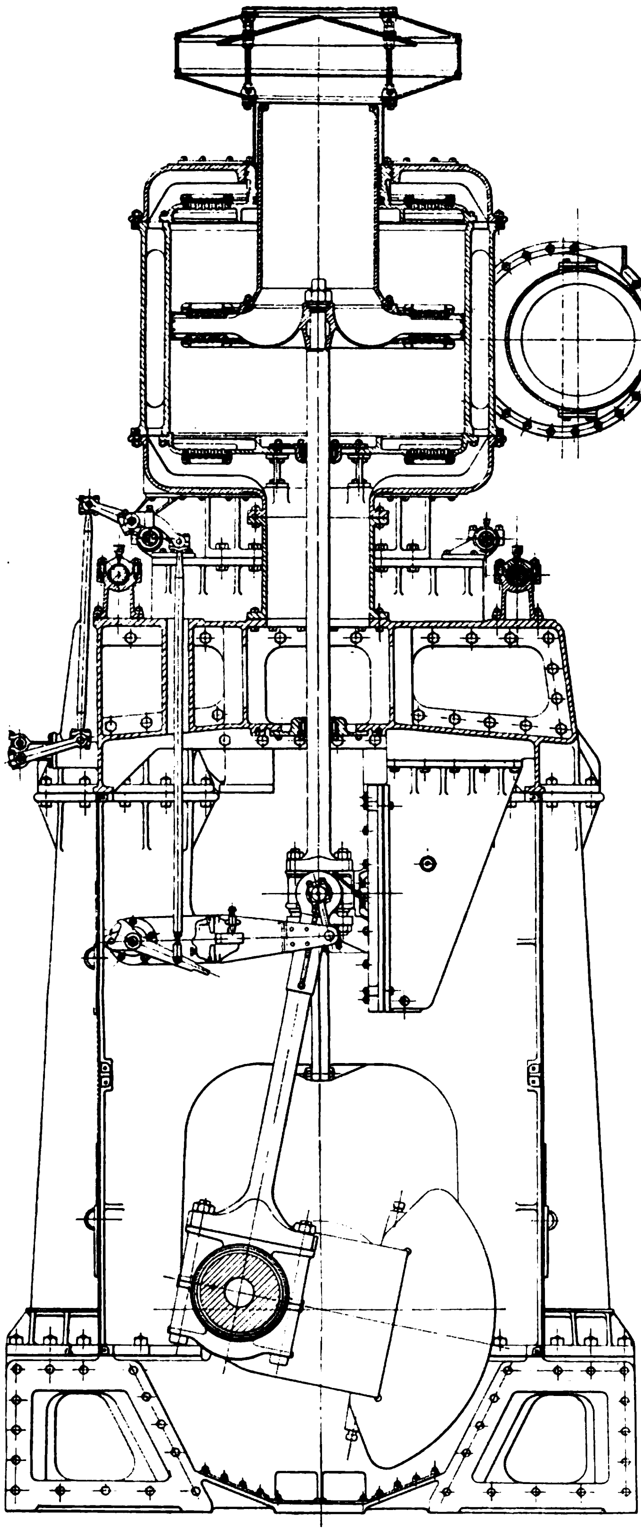
The first class public rooms occupy a considerable space on the promenade and boat decks; also on the upper and main decks, including observation lounge, social lounge with large gallery above, smoking room, verandah café, foyer, dining saloon, writing room and library, gymnasium, and a large dancing and promenade space aft of verandah cafe, which can be completely enclosed, or opened up as desired.

The dining saloon, capable of seating over 400 passengers is a lofty apartment running up through three decks with ceiling domes, lit by concealed lights and galleries at the sides supported by alcove piers.

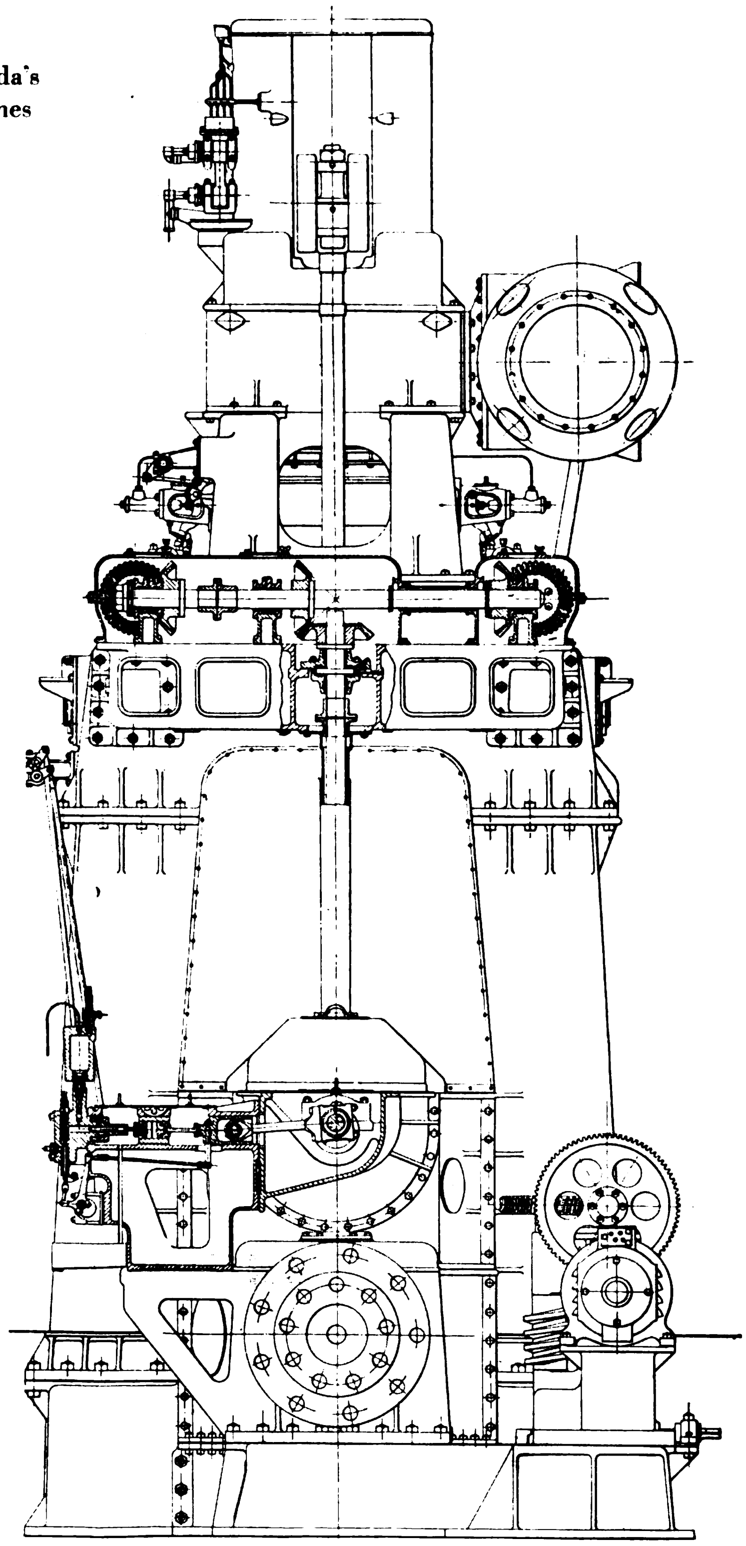
The cargo spaces on the BERMUDA are protected against fire by the Lux-Rich System. This equipment both detects and extinguishes fire.

The main propelling machinery, built by Wm. Doxford and Sons, Ltd., Sunderland, consists of four sets of Doxford patented airless injection opposed piston oil engines arranged abreast and driving four screws. The engines are of 2-cycle design, combustion taking place between two opposed pistons working in a cylinder open at both ends. The lower piston drives the crankshaft by means of a cross-head and connecting rod in the usual way. The upper piston carries a transverse yoke of forged steel, from the ends of which side rods extend downwards past the cylinder and each terminates in its own cross-head. From these latter cross-heads connecting rods descend to two crankpins, which are set diametrically opposite that to which the

Ms. Bermuda's Main Engines



The double-acting scavenge pump, centrally situated between the cylinders is driven directly from the crankshaft



View looking on the aft end of the engine showing camshaft and fuel pump drive

lower piston is connected. Thus there are three cranks to each cylinder.

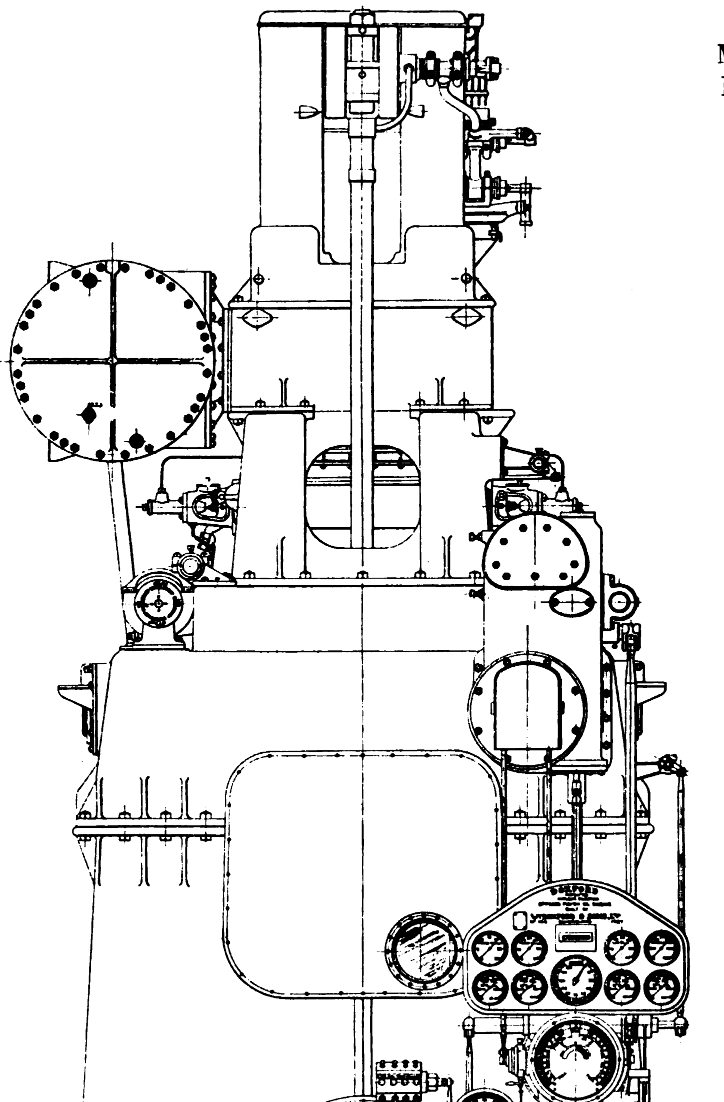
The engines are 4-cylinder units, each having two working pistons 23⅝ in. diameter, the stroke of the lower piston being 41 in. and that of the upper pistons 30 in.

Each engine develops normally 2800 b.hp. at 110 r.p.m., but is capable of developing 3400 b.hp. at 118-120 r.p.m. and weighs complete with thrust-block flywheel main fuel pump about 300 tons.

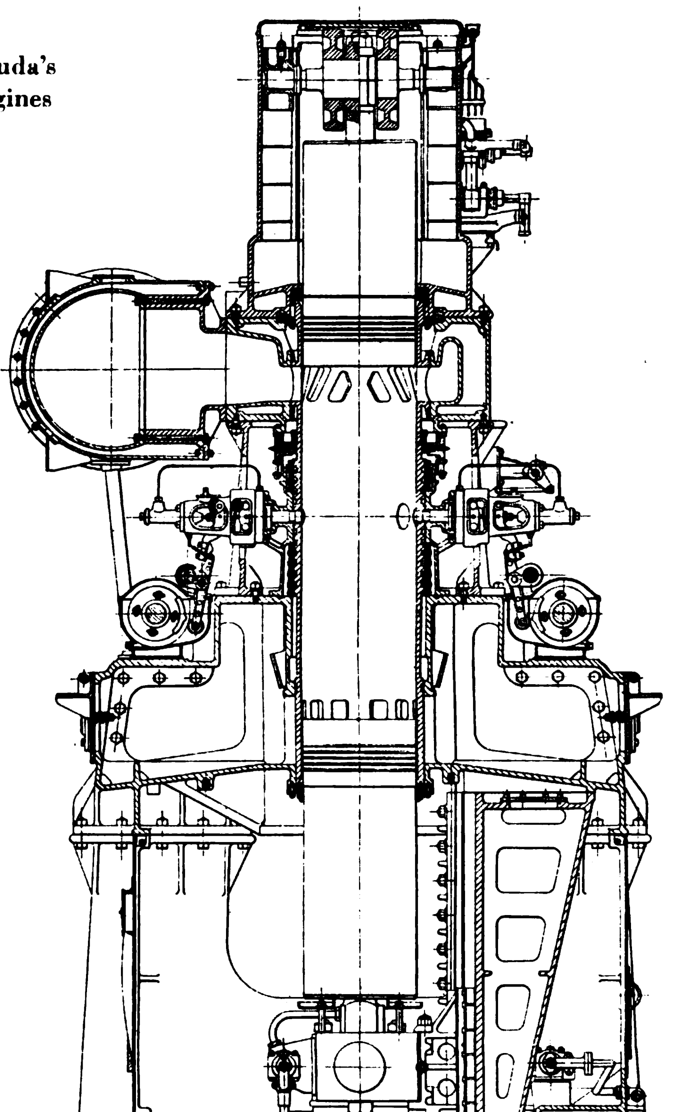
Hitherto all Doxford engines have been built with equal strokes for upper and lower pistons and a ratio of total stroke to bore of 4 to 1. The ratio in the BERMUDA engines is 3 to 1, the reduction being necessary to bring down the overall height to keep the engines and traveling cranes for overhauling below E deck. The builders have evolved in these engines a 4-cylinder engine with cranks at right angles, perfectly balanced not only for priming vertical and horizontal forces and couples, but also for secondary vertical forces and couples. This has been rendered possible by adopting a shorter stroke for the upper pistons than that for the lower pistons, the strokes being inversely proportional to the reciprocating weights. This means that as the upper and lower pistons are moving in opposite directions there is no primary resultant vertical force in any cylinder and therefore no primary vertical couple. With the strokes adopted it was found that the unbalanced revolving force due to the centre crank-pin and connecting rod bottom end was slightly greater than the corresponding opposite revolving force of the side pins, and this was corrected by making the centre crank-pins hollow. Thus there is no horizontal unbalanced force in any cylinder and, therefore, no couple.

There still remain the secondary vertical forces, which, of course, for lower and up-

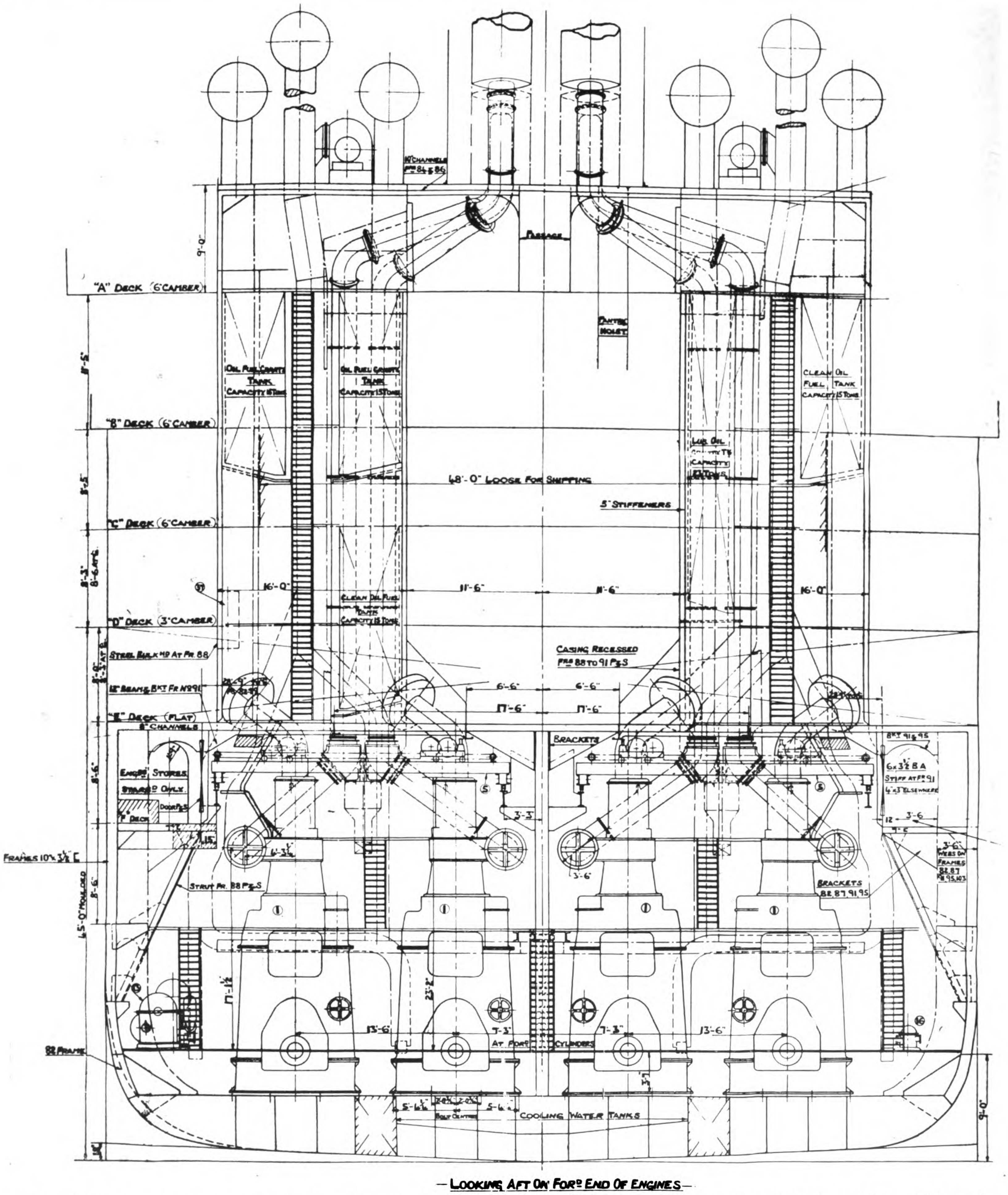
Ms. Bermuda's Main Engines



Controls of each engine are located at the forward end at bottom platform level



Section in way of a cylinder shows the 41 in. lower and 30 in. upper strokes



Section through machinery space of motorliner Bermuda shows how little vertical space is absorbed by the vessel's four main propelling units

per pistons of each cylinder, act in unison, as the cranks are opposite one another. By arranging the crank sequence 1, 2, 4, 3, in place of the usual 1, 3, 2, 4, the unbalanced secondary forces of 1 and 4 are acting in unison, but are opposed by the unbalanced secondary forces of 2 and 3, which are equal in value but are acting in the opposite direction. Thus there is neither resultant secondary force nor couple.

Summing up, the primary forces are eliminated by carefully proportioning the revolving and reciprocating weights of the pistons of each individual cylinder to be inversely proportional to their respective strokes. The secondary forces and couples are eliminated by a collective system of balancing.

The engines were run on the test bed at 155 r.p.m., developing 4000 b.hp. each, and at this speed the surface of water in a buck-

et placed on the top platform did not show the slightest tremor a remarkably severe test. An ordinary lead pencil would stand on end in the same place.

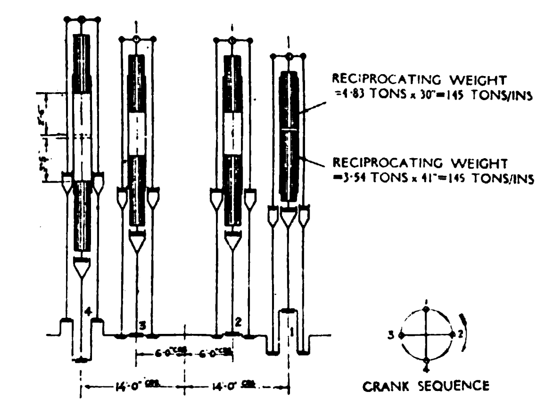
The reciprocating and revolving weights of the scavenge pump still require consideration, so the piston and connecting rod have been made as light as possible and balance weights added to the crank webs, equal in effect to the revolving and reciprocating weights of these. This results in an unbalanced vertical secondary force of 1½ tons and a horizontal force of 7½ tons when the engines are running at 120 r.p.m., a negligible quantity for main engines, weighing 300 tons. With turbo-blowers even these unbalanced forces would be absent.

The cylinder liners are of cast-iron, machined all over both inside and out, and all parts are cut from the solid. The bars between the exhaust ports are drilled hollow for water-cooling. The maximum thickness of the liners is 1 in. and as this thickness is insufficient to withstand the combustion pressure, the liner is reinforced by a cast-steel jacket carrying the housings for the valves and by forged-steel shrink rings. Each cylinder is provided with two fuel valves, a non-return starting valve, a relief valve and an indicator valve, all valves being placed radially on the centre line of the combustion space. Combustion takes place between the hollow faces of the two pistons, which are made of forged ingot steel and are machined out of the solid. Each piston is fitted with five cast-iron piston rings, the grooves being provided with special hardwearing renewable surfaces on the outer side and a flexible sealing lip on the inner edge, these features, being responsible for the remarkably long life of the piston rings and cylinder liners. The piston heads are maintained at a high temperature, which materially assists combustion.

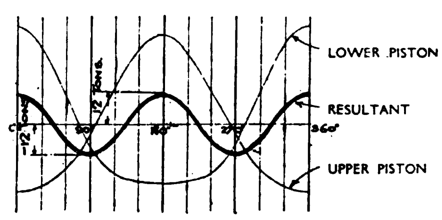
The pistons are deeply dished, forming a spherically shaped combustion space, and their edges are only about 2 in. apart on the inner dead centre, thus protecting the cylinder walls from the intense heat of combustion.

Centrally situated between the cylinders is a double-acting scavenging air pump, driven directly from the crankshaft, the diameter of the pump being 62¼ in. and the stroke 34⅝ in. The piston is of manganese bronze, with bronze disc valves and aluminum valve guards, a suction trunk of aluminum being bolted to the piston. The delivery valves are annular disc multiple-ported valves similar to the suction valves in the piston, there being thus only four disc valves in each pump. The scavenging air is drawn through suction silencers of special form lined with mascolite, and these are remarkably efficient in deadening the noise often associated with such suctions.

From the delivery valves the air passes into the column bridges or entablature of the engine, which forms a continuous air receiver communicating with the lower ring of ports in all four cylinders. At the end of the outward stroke of the piston the upper piston uncovers the ring of exhaust ports in the upper end of the liner. The products of combustion at once escape into the exhaust manifold and reduce the pressure within the cylinder to that of the atmosphere. Then the lower piston uncovers the scavenging ports already mentioned and a blast of fresh air sweeps through the cylinder from end to end. The scavenging is thus "uniflow" or all in one direction and is remarkably efficient, thus establishing one of the conditions necessary to enable an engine to be run at high mean indicated pressures. The scavenging air pressure at full power is about 2 lb. per sq. in., the swept volume of the scavenging pump being 30 per cent. in excess of the volume of the working cylinders.



TOTAL UNBALANCED VERTICAL FORCE FOR 1 CYLINDER.

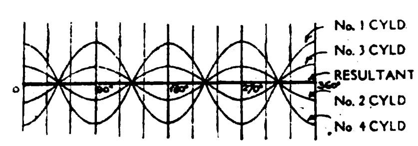


UNBALANCED HORIZONTAL FORCE FOR 1 CYLINDER = NIL

UNBALANCED VERTICAL AND HORIZONTAL FORCE FOR COMPLETE ENGINE = NIL

UNBALANCED HORIZONTAL COUPLE FOR COMPLETE ENGINE = NIL

UNBALANCED VERTICAL COUPLE FOR COMPLETE ENGINE.



UNBALANCED VERTICAL COUPLE NIL.

BALANCING DIAGRAM FOR ONE OF BERMUDA'S MAIN ENGINES, NEGLECTING SCAVENGE PUMP EFFECT

The air entering the cylinder is given a slight rotary motion, which promotes turbulence and ensures that the fuel comes intimately in contact with all the available oxygen and this ensures rapid and complete combustion.

In common with all Doxford engines, airless injection of fuel is employed. At the after end of each engine is placed a four-throw fuel pump gear driven by equal spur gears from the thrust shaft. The pump bodies are of chrome-nickel steel and glandless packing is employed for the rams, which are of casehardened steel running in special cast-iron bushes. The power absorbed by the pump is about 20 b.hp., or about 0.7 per cent. of the power of the main engines. Each connecting rod drives a cross-head to which a second cross-head is flexibly attached, the pump plungers being flexibly attached to this second cross-head. The underlying principle is to produce a pump capable of working against 8000-10,000 lb. pressure for long periods, any side strain of the connecting rod being prevented from affecting the plunger by the intermediate cross-head and flexible connections. When running, all four rams deliver into a common system, although means are provided that each ram can supply its own cylinder only and can be cut out if occasion necessitates. The isolating valve also enables the piping to be tested in independent sections. The fuel delivery is regulated by the system usually adopted for Diesel engines; that is, by holding the suction valves open during a greater or less portion of the delivery stroke. This is effected by a hand control from the control station or by the Aspinall governor, which is operated from the control station at the forward end of the engine. This control is quite independent of the hand control.

Two duplicates of the main pump are arranged at the forward end of the engine-room, each being driven by spring gearing from a 20 b.hp. electric motor. Two rams of each pump are normally connected to the system of one of the four engines, but arrangements are made that the port auxiliary pump can deliver to either of the port engines in case of necessity, the starboard pump being similarly arranged. These pumps are also employed for priming and testing the system before starting the engines.

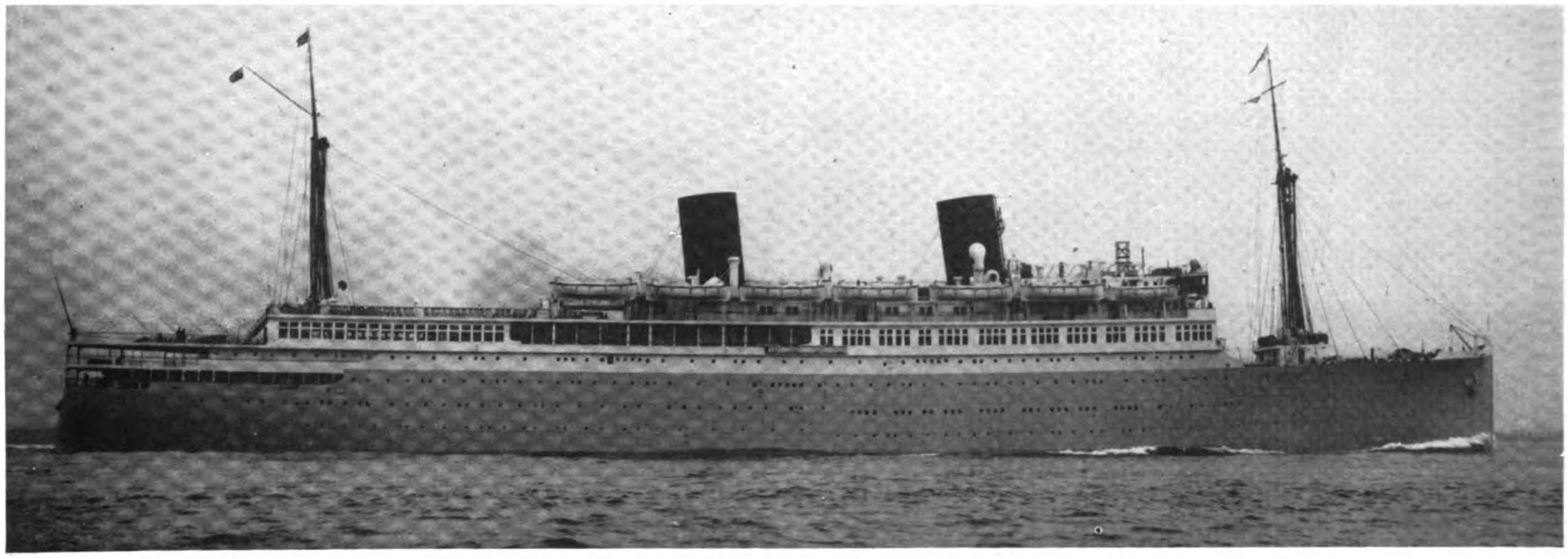
The crankshaft, which has 13 throws, is 38 ft. long and weighs 38 tons. The main journals are 17 in. diameter and the crank-pins 18¼ in. diameter. The shaft is in three pieces, the length for two forward cylinders, the length for the two after cylinders and the scavenging crank-pin and its webs which form the coupling between the two pieces. The shaft is drilled for forced lubrication, but in no case is oil led through a coupling face or a shrunk joint, external steel pipes being fitted at these points. The shaft is made of ordinary ingot steel 28-32 tons tensile and runs in six spherical bearings. All bottom end bearings are also spherical, thus allowing any slight deflection of the shaft to be accommodated.

The bearing pressures of the cross-head pins is 1100 lb., of the crank-pins 650 lb., of the center guide shoes 30 lb., and of the side guide shoes 50 lb.

The main bearings carry no load except the dead load of the running gear, the actual bearing pressure being about 100 lb. per sq. in. This is an important factor in preserving the alignment of the crankshaft, as wear here is negligible and the original white metal will, in all probability, outlast the life of the vessel.

Any of the half-crankshafts can be removed from the engines by removing only the two columns immediately in front of the section, the rest of the main framing being left undisturbed.

The control station of each engine is arranged at the forward end, so that all four operators can be seen from a central



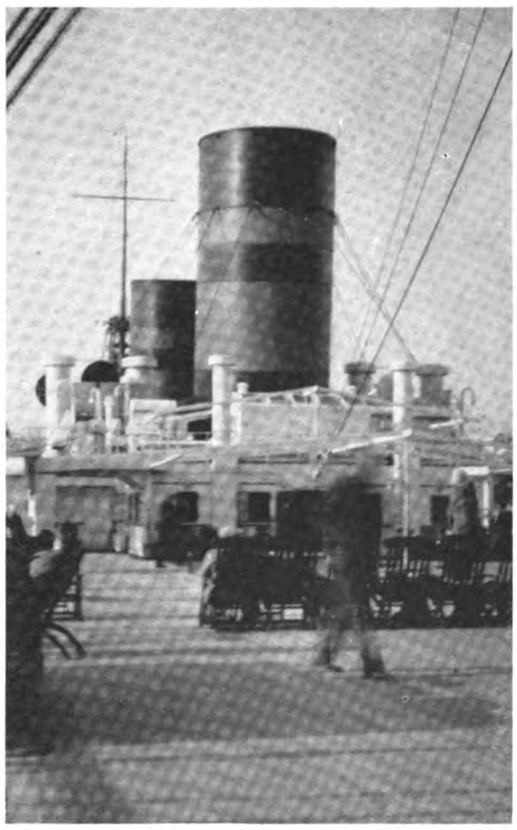
The big dance hall aft on A deck and the big open sports space on the Sun Deck lend an appearance of attractiveness to the new motorliner

position and orders more easily carried out. No servo-motors are employed, all operations being carried out by hand power. Each engine has two camshafts—one in front and one behind—driven by spur-and-bevel bearing from the thrust shaft. The front shaft carries two sets of cams—one for ahead and one for astern running—and is made to slide longitudinally by a large hand lever on the operator's right hand. The back camshaft is non-sliding and drives the back fuel valves, indicator cams and lubricator cams. When going astern, the back fuel valves are not called into operation, ample astern power being available from the front valves. The engine is started and the speed controlled by a large handwheel suitably interlocked with the reversing lever. This wheel puts all four cylinders on air and, by a continuous rotation in one direction, cuts air off and puts fuel almost instantaneously on to all four cylinders from the front valves only. Further rotation increases the lift of the front valves, brings the back valves into operation until, at the full-speed position, both valves are opening equally and the timing made suitable for full-speed running. The timing of the fuel valves is peculiar—25 deg. before T.D.C. to 25 deg. after T.D.C. at full speed—but it must be remembered that the engine compression is only about 285 lb. per sq. in. and the maximum pressure 570 lb., the engine working on the dual combustion cycle part at constant volume and part at constant pressure. The fuel pressure is controlled by a small handwheel at the operator's left hand, which regulates the trip gear on the suction valves of the fuel pump.

Above the control station is mounted a bronze gauge board carrying four pressure gauges for fuel, one for starting air, one for lubricating oil, one for piston water, one for jacket water, and on the column a mercury gauge for the scavenging air. The gauges are inserted from behind, and a combined tachometer and counter are similarly mounted in the centre of the board.

Each cylinder is provided also with a water-cooled relief valve loaded to 710 lb. per sq. in. This valve provides a useful indication of excessive pressure in any cylinder.

The pistons and cylinders are cooled by distilled water, the inlet temperature being maintained at about 140 deg. F. and the outlet temperature about 155 deg. F. The pressure on the jackets is about 15-20 lb. and on the pistons about 40 lb. The lower piston cooling water is conveyed by two sets of swinging links with semi-rotary glands and the upper piston by similar gear for the inlet, but the outlet by telescopic tubes. The glands are self-fed by spiral springs and run for about 50 days without attention. The cooling water is preheated to about 140 degrees F. before starting, thus ensuring quick and reliable starting independent of the sea or atmospheric conditions. All cooling water returns to visible flow hoppers on the middle platform, each cylinder and piston having a separate thermometer.



No annoying soot and clinkers can annoy passengers on the steamless Bermuda

For removal of pistons, two electric cranes are provided—one for the port engines and one for the starboard engines. No high-pressure joints have to be broken to remove either piston and both can be removed within 30 min. of stopping the engine.

Very little headroom is required for removal of pistons. From the top of the top guides to the underside of the deck beams measures only 3 ft. 3 ins. and the actual height of lift of top guide to clear the upper piston from the cylinder is 14 ins.

The crankchamber is provided with eight large aluminum access doors about 36 ins. diameter, which can be lifted out without use of a spanner for inspection of bottom ends of cross-heads. The upper doors are provided with 8-in. glass port lights, through which the piston skirts, etc., can be inspected while the engines are running, the crankchamber being illuminated by five electric lamps. The crankchambers are provided with permanent spar gratings for overhaul of cross-heads, and ample space is available in the crankchamber and bedplate for overhauling.

Aft of the main bedplate is an extension girder carrying the thrust block and turning gear. The thrust block is of the Michell type, with bath lubrication, with copper cooling coil in the base. An 18 h.p. electric motor is provided for turning the engines with spur and double-worm gear reduction.

The engines, when tested at the makers' works, gave a consumption of .385 lb. per b.hp. hour at 110 r.p.m. and 2,800 b.hp., and on overload a consumption of .395 lb. per b.hp. at 118 r.p.m. and 3,400 b.hp. The mechanical efficiency at normal load is exactly 90 per cent.

The contract for the four engines placed with Messrs. Doxford on August 26th, 1926, provided for the engines to be shipped by August 31st, 1927. The engines were designed, built, tested and despatched by August 3rd, 1927, practically a month ahead of schedule, in spite of the difficulties of the protracted strike in the coal-mining industry, in Great Britain.

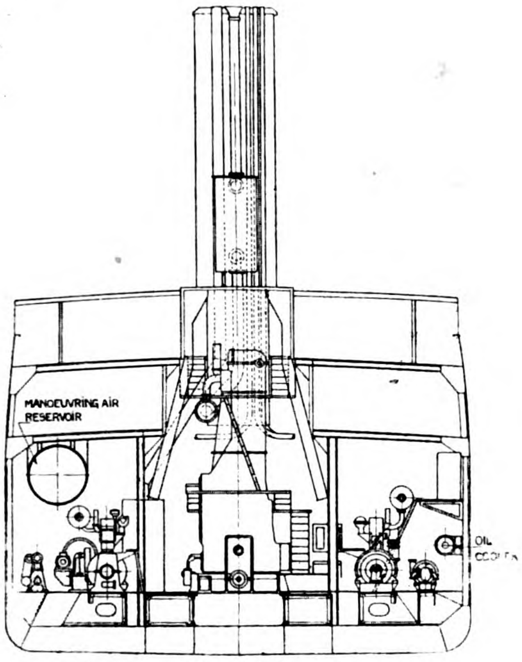
A batch of six Sharples centrifuges is used to take care of fuel and lubricating oil requirements. Of these three are for fuel oil, two for lubricating oil and one for either purpose. These are fitted on a flat at the forward end of the engine room. The main engine room contains the usual pump equipment and also maneuvering air compressors. All of these are actuated by electric motors.

New Motorship Operating from New York

Ms. Irland, Engaged in South and Central America Trade, Powered with Modified Long Stroke 4-cycle Diesel with No Flywheel

THE new motorship IRLAND, operated by the Meridian Line, Inc., of New York, docked on December 30th on her maiden voyage with a cargo of wood pulp from Gefle. She has now been placed in South American service from New York, via Panama, making Guayaquil, Ecuador, the first port of call.

Although she unfortunately suffered minor damage in collision upon her arrival in New York harbor, repairs were completed so as not to delay her scheduled sailing date set for January 12th. On her initial voyage to southern waters she carried a general cargo amongst which was the first of the new model Ford cars for Guayaquil. She will return with a full cargo of nitrate from South America.

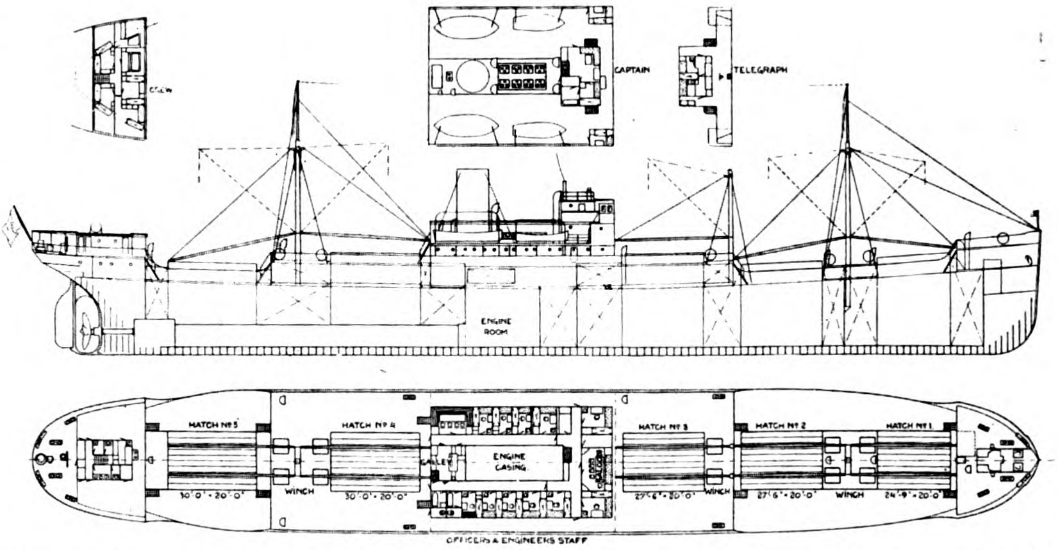


Section through machinery space

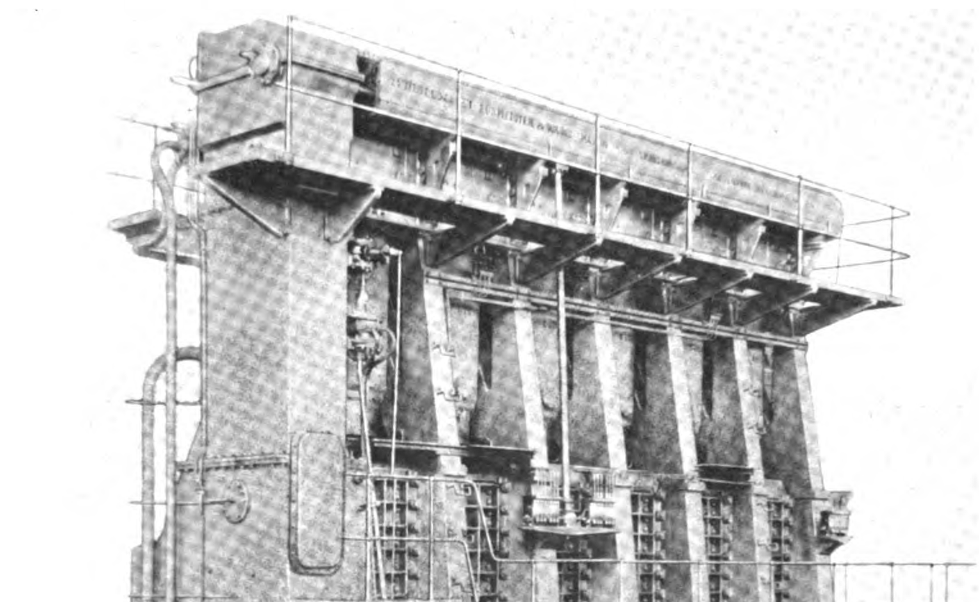
Ms. IRLAND was built at Copenhagen, and is engined with the latest B. & W. cross-head type, light weight, single acting, long stroke, 6 cylinder Diesel for the propulsion of her single screw, developing 1600 i.hp. at 95 r.p.m. Several unique features are incorporated in this engine. It has no push rods, the cam shaft being located on top of the square cylinder covers and driven by a chain at the aft end. The engine is very short. It is also specially balanced. There is only a turning gear wheel and no flywheel as will be noticed in the illustration. The IRLAND'S engineers report perfect engine performance on the trip from Gefle which was made at the average speed of 11.6 knots and with an average fuel consumption of approx. 139 grams per i.hp. hour. The fuel carrying capacity is about 500 tons providing a radius of operation of about 24,000 miles.

Cargo is handled through five hatches with two 3-ton steel tube derricks for each hatch and one 3-ton winch for each derrick. All auxiliary deck and engine room machinery is electrically driven with current supplied by one 66 kw. and two 33 kw. generators directly coupled to one 100 b.hp. double-cylinder and two 50 b.hp. single-cylinder Diesel engines, respectively.

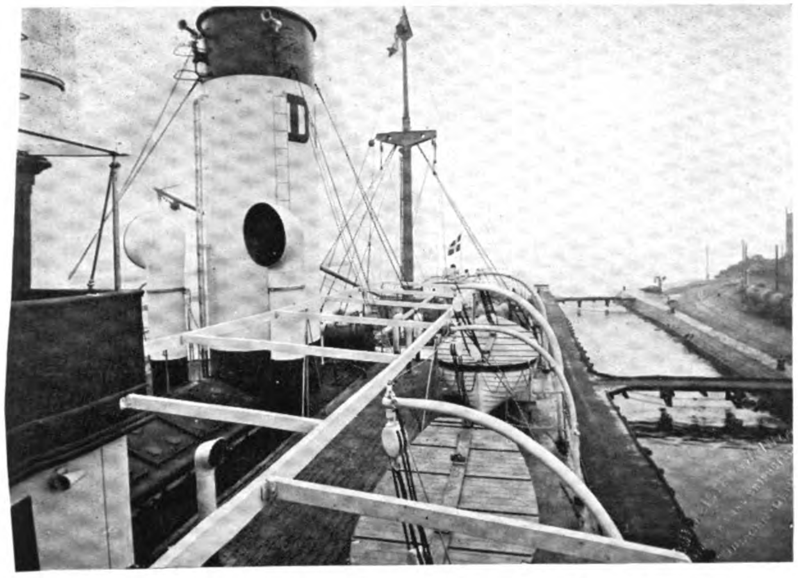
The vessel is electrically lighted throughout and to avoid running one of the large dynamos exclusively for lighting, a Delco light plant has been installed. The steering gear is of the electric hydraulic type and is controlled from the bridge by a telemotor. An emergency steering gear is



Ms. Irland, operated by Meridian Lines, has long bridge space and trunk hatchways in wells



Six cylinder long stroke 4-cycle 1600 hp. Diesel propels Ms. Irland at 11.6 knots



Two compressed air sirens are located on the oval stack

View forward shows the trunk arrangement of Nos. 1 and 2 hatches

A visit to the ship shortly after her arrival at New York left us with an impression of neatness and cleanliness—especially of the engines and engine room. The officers' and engineers' quarters are located in the deck house built around the engine casing and are comfortably and tastefully appointed. The saloon is situated in the foremost part of the casing house and on each side of the saloon are two roomy passenger cabins fitted out in mahogany. Bath room and galley floors are tiled. The captain's quarters are placed on the boat deck and in the side houses, also on the boat deck, are located the hospital and accommodations for the electrician. The crew is quartered in the poop deck in cabins for three men each. The provision stores are refrigerated by a Frigidaire. All accommodations are steam heated by means of an oil-fired donkey boiler forward in the motor room.

Ms. IRLAND is the first motorship in the fleet of "Det Dansk-Franske Dampskibsselskab." Her sister ship is now building and when completed, which will be soon, she will be placed in the same service as the IRLAND by the Meridian Line, Inc. of New York City. The IRLAND is commanded by Capt. K. Haure-Petersen and sails under the Danish flag.

The Worlds' Largest Motoryacht

THE world's largest, privately-owned Diesel yacht, SAVARONA, owned by Richard M. Cadwalader, Jr., prominent Philadelphia banker, has just been completed at a cost of approximately $2,-000,000. Henry J. Gielow, Inc., are the designers.

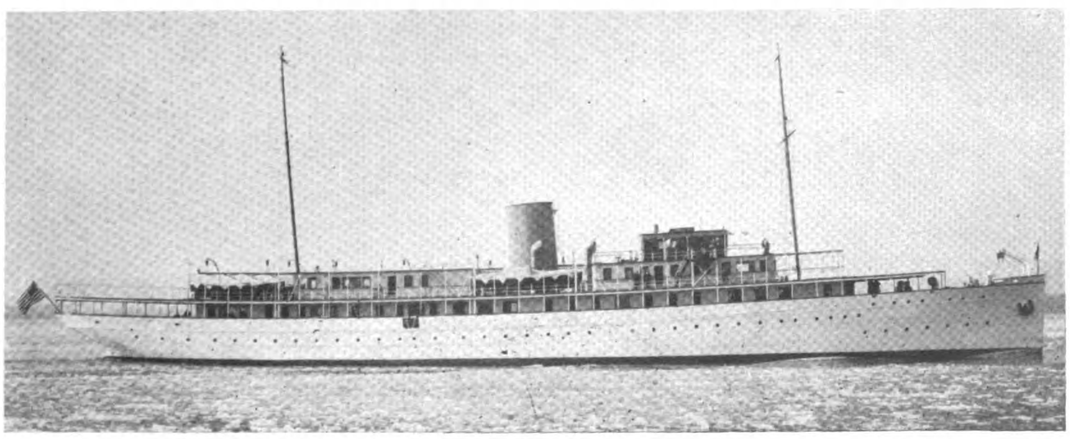
Ms. SAVARONA, newest addition to America's list of palatial ocean-going motor yachts—is 294 ft. 0 in. in length, with a beam of 38 ft. 3 ins. and a draft of 16 ft. It exceeds by almost 30 feet in length the Diesel yacht now being built abroad for Vincent Astor. In addition to being the largest privately-owned, pleasure Diesel craft in the world, there are said to be only some six private yachts in this country which actually exceed it in size, all of these, however, being older type steam yachts of clipper design with jutting bows and sterns above the water-line.

Ms. SAVARONA is said to have a cruising radius of approximately 20,000 miles. The fuel capacity is 102,000 gal. and the maximum speed is 18 knots. She is manned by a crew of 45 men, and is expected to leave New York in February with her owner for an extensive cruise to Havana, the Panama Canal and South American ports.

The keel of the ship was laid the latter part of March 1927 and the hull was launched in September. The yacht of this size has thus been completed within a period of 12 months.

The power equipment consists of two-1500 hp. Bessemer Diesel engines for the main driving unit, with Bessemer Diesel generators and large storage batteries to furnish the electrical power for operation of the many auxiliaries and mechanical appliances. The main engines are 8 cylinder 18 in. by 22 in. 4-cycle airless injection units of noteworthy design described in our issue of October 1927. The latest and most modern navigational and steering equipment is installed, including a Sperry gyro compass and a Sperry gyro pilot.

To eliminate any and all possibility of rolling, the new SAVARONA is equipped with a Sperry gyro stabilizer.



Worlds largest Motoryacht Savarona, powered by two 1500 hp. 4-cycle airless injection Diesels

Bids for Auxiliary Diesels for U. S. Shipping Board

Bids for the construction of 20 Diesel auxiliaries, details of which were referred to in our January issue, for installation in 8 vessels of the Shipping Board Fleet, were opened as we go to press. Unfortunately an analysis of the bids cannot be made in time for publication in this issue. The following manufacturers submitted bids: Bethlehem Steel Co., Busch-Sulzer Bros., C. & G. Cooper Co., De La Vergne Machine Co., Fairbanks, Morse & Co., Fulton Iron Works Co., Ingersoll-Rand Co., McIntosh & Seymour Corp., Worthington Pump & Machine Co., New London Ship & Engine Co. and the Nordberg Mfg. Co.

Manufacturers were asked to bid on six different sizes of engines with corresponding arrangements of compressors and generators. The bidding was thus of a very complicated nature as many manufacturers submitted different prices for different types of generators. Figures which we have before us at present are not official figures but they show great competition in bidding and indicate that the Diesel industry has a very wide range of types and sizes of auxiliary Diesels suitable for marine work. The official figures will be published as soon as they are tabulated and released by the Shipping Board.

New Diesel-Electric Sand Dredge

River Sand Company of Steubenville, Ohio, Places Sand and Gravel Dredge "Admiral" in Service for Heavy Duty

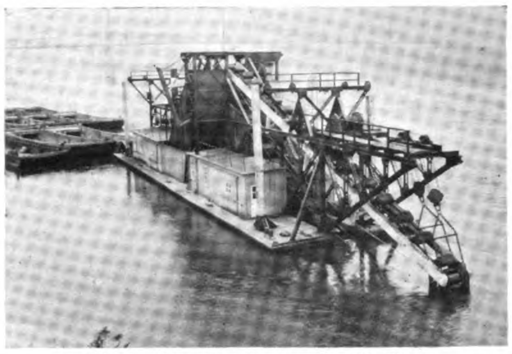
THE field for Diesel-driven dredges has widened enormously during the past few years. One of the most recent installations to go into service is the new Diesel-electric sand and gravel dredge ADMIRAL which was placed in commission recently by the River Sand Company of Steubenville, Ohio. This dredge is equipped with a 6 cylinder, 200 hp., 125 kw., 250 volt, direct current Diesel generating set which furnishes all of the current for operating the dredge. The main engine is a Fairbanks, Morse Diesel.

This dredge has a main digging frame 91 ft. long and with 33 buckets on the digging chain each having a capacity of 6½ cu. ft., or a digging capacity of about 300 tons an hour. The molded length of the hull is 130 ft. 10 in. while the overall length is 159 ft. The molded beam is 29 ft. 7 in. and the overall width of the dredge is 33 ft. The average draft is 3.89 ft. and the total weight of the dredge with fuel bunkers half full is 858,339 lb.

As this dredge is completely electrified it is possible for one operator to control all machinery from the cabin located on the deck house. It is also equipped with electric signals and speaking tubes in various parts of the dredge so that the operator has unusually complete control of both the dredge machinery and the crew.

The digging buckets deliver the material to large screens where it is washed, separated and classified. A high gallows frame is a special feature with a three-way chute system which enables the sand, gravel and waste material to be delivered to the center of any type of barge that happens to come alongside.

The hull is constructed of special copper bearing steel plate to resist corrosion and



Main digging frame 91 ft. long

the steel framework above the deck is of unusually rigid design. Manganese steel chains are used for the support of the manganese buckets making up the digging ladder.

The spuds are very long which make it possible for the dredge to dig in deep water without additional protection in the way of anchors although provision for anchors has been made.

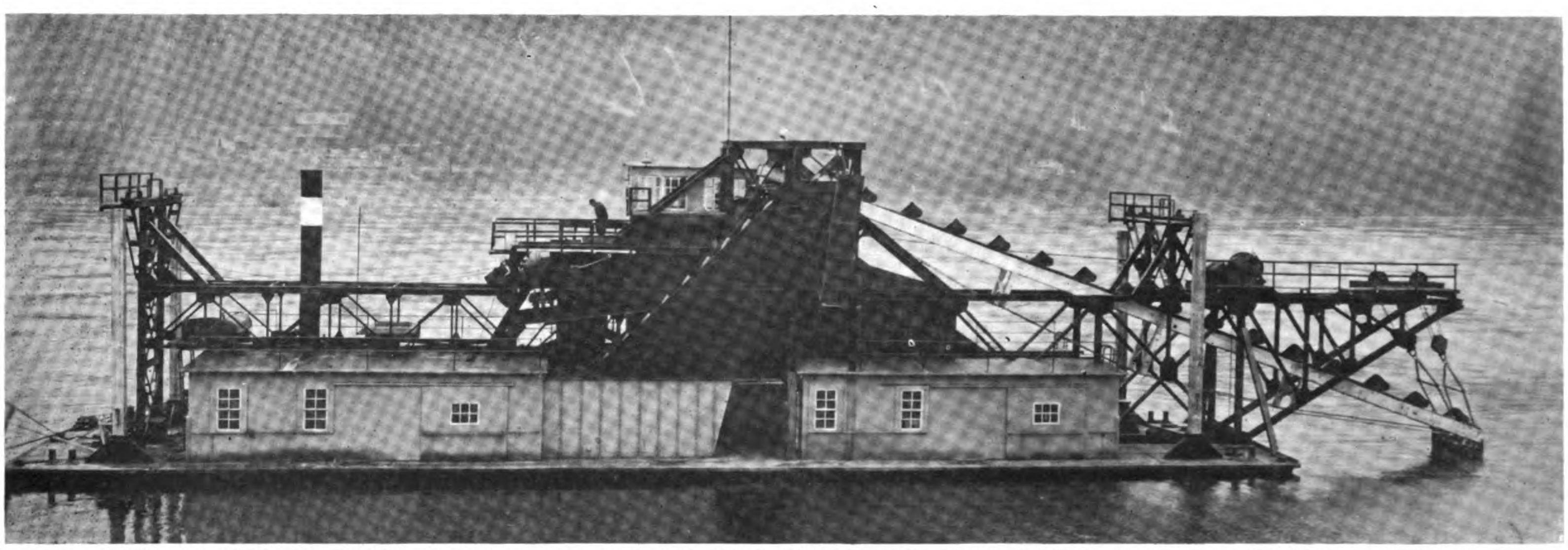
An unusually spacious engine room is provided on the dredge. In addition to the built-in compressor and circulating water pump with which the engine is equipped there is also a duplicate water pump and auxiliary air compressor. The switchboard in the engine room is fitted with circuit breakers and relays of the latest type and in addition all of the motors which are controlled from push button stations are protected with both overload and no voltage starters. All of the wiring to the motors is enclosed in conduit with the latest type at various points on the boat to provide of marine fittings. Small heaters are used heat in severe weather.

The design of the dredge was worked out by H. G. Dohrman and W. A. Tisher of the River Sand Company. The owners are highly pleased with the operation of the new equipment and particularly the freedom from vibration.

A particularly desirable feature in the opinion of the owners is the fact that the new dredge will only have to be re-fueled once or twice each season and can work on a location for several weeks at a time if desired.

That the sand and gravel business has become a highly specialized kind of work is shown by the modern type of equipment which is going into this service. With Diesel power it is not only possible to reduce the cost of operation but with modern dredges for scientific handling of the material it is possible to produce the clean, well graded aggregates now demanded for construction work.

The River Sand Company also has a very complete shore plant and facilities for loading and weighing wagons and trucks. The company sells sand and gravel to road contractors, the building trades and steel mills in the territory and their shipments cover a good part of Eastern Ohio. The new Diesel dredge will not only lower the costs of operation but will make it possible to serve a larger number of customers.



The Diesel-electric dredge Admiral, powered by a 6-cylinder 200 hp. Diesel, has a digging capacity of 300 tons per hour

France's First Motorship Now Passenger Liner

After more than 84,000 miles service over a period of 2 years, the cargo motorship CAMRANH, built by Atel. & Chant. de la Loire for Charguers Reunis, Paris, is being converted into a passenger liner at the Penhoet yards. The ship will be renamed BRAZZA and will be placed in service on the East African Line. Ms. BRAZZA is 460 feet long and is being fitted with comfortable accommodations for 178 first-class, 90 second-class and 90 third-class passengers. The two Sulzer 2-cycle Diesel engines, developing a total of 5400 b.hp., have given such excellent results that no alteration will be made in the propulsion machinery. The ship when completed will have two stacks and the usual passenger ship superstructure.

Safety Devices and Engine Cooling

The Fitting of Ample Safety Devices on Diesel Engines Is Valuable and Necessary Insurance Against Possible Disaster

By Chief Engineer

ACCEPTANCE of different safety devices as part of the necessary engine accessories has contributed greatly to success in the operation of motorships. Methods of making the engine "fool-proof" are not confined, however, to the addition of small patented mechanisms. We find that improved features of engine design and better methods of machinery space arrangement are doing much to simplify the work of the engineer and render operation of the machinery more dependable.

One of the best examples of this sort of development was the introduction some years ago of pressure lubrication to the bearings which eliminated the need of watching numerous drip feeds and feeling the bearings for heat, a practice which was not without its element of danger to the oiler. This system also provides a more efficient method of lubrication. Its weakness lay in the fact that if oil should stop at all it would deprive the entire engine of its supply with characteristic damage which led to the use of a low pressure alarm system whereby the ringing of an electric bell warns the operator of such failure.

One recalls an instance of severe damage to an engine as the result of not having an alarm on the cooling water system. An auxiliary engine stopped unexpectedly a few hours before reaching port. In the excitement of getting another engine started and all of the auxiliaries running once more the main circulating pump was overlooked and the engines became too hot for safe operation. Perhaps the engineer was inexperienced or excitable. At any rate he started the circulating pump just as soon as he discovered the hot engines and circulated cold sea water through them. At first it appeared as if no damage had been done for the engines ran along until the ship reached port and was safely berthed.

At sailing time an attempt to start the main engines resulted in a cylinder head being lifted clear of the liner. Some of the studs were broken and some torn out of the cylinder. The damaged parts were replaced with spares. The engine was then started and after running a short time a great commotion took place in one of the main bearings. A sprung crankshaft, a broken bearing cap and a cracked bedplate were then found. Needless to say this was a cause of commotion to everyone concerned.

It later developed that a cylinder head was cracked when cold water was turned into the hot engine at sea but the crack did not admit enough water to the cylinder to interfere with operation while coming into port. It opened up when the engine cooled and enough water leaked into the cylinder to more than fill the combustion space. The engine failed to maneuver ahead and the engineer tried her astern. She swung almost a complete revolution when the water on the piston fetched up against the cylinder head and closed valves with the resultant damage just described. Perhaps the operators can be justly criticised in this instance but it is also possible that an alarm system would have prevented the damage.

It appears that not enough serious thought has been given to engine cooling methods. A system that is ideally suited to one ship and her engines may not be suited to all. Some engine manufacturers, some ship owners and some operating engineers look upon engine cooling as one of the simplest problems of operation since the ship in her natural element is provided with an abundant supply of water, pumps are very dependable and thermometers will indicate the various temperatures with a satisfactory degree of accuracy. In spite of all of this, engines sometimes suffer for want of proper circulation.

The ideal method on all engines is to maintain a maximum flow of water with a minimum rise in temperature. In other words have the cooling water enter the jackets at a temperature so high that the heat carried off will bring the overflow temperature exactly right when the circulating pump is working at full capacity. Since sea temperatures are not the same throughout the world it is then necessary to heat the cooling water before it enters the engine and the simplest means of doing this is to recirculate a portion of the cooling water when the sea temperature is low. This involves the installation of a bypass pipe between the overboard line from the engines and the suction pipe of the circulating pump with values so arranged that any portion of the water which has been used for cooling may be pumped through the jackets again.

Some vessels are in trades which make a system such as this so essential that it is the height of folly to be without it. Rivers such as the Delaware are extremely cold during the winter months while ice floes disturb the banks and bottom making the water very muddy. It is desirable to maintain a fairly high temperature of the engines while maneuvering or running slow and in so doing the water circulated is reduced to the smallest possible amount without causing circulation to one or more cylinders to stop entirely. Sometimes the water is stopped in order to avoid chilling the engines between maneuvers. This permits the mud to settle in the jackets which would not occur with a rapid flow and characteristic agitation.

To maneuver a stone cold engine sometimes overtaxes the maneuvering air supply and in order to overcome this difficulty when leaving the dock in a cold harbor the engines are either preheated with steam to the jackets or started up at the dock and run until they are warm. Thereafter the engineer must be careful to avoid pumping the jackets full of cold water and forcing out that which has been heated. Obviously the flow of water must be stopped entirely when the engine is stopped.

It is dangerous to stop the flow of circulating water because the crown of the cylinder heads may become uncovered and heat with a few maneuvers and then be suddenly chilled when the flow of water is again started. The average engineer realizes this danger but chooses the lesser of two dangers. To him dependability in maneuvering is of paramount importance while leaving or approaching a dock. He would prefer to release such steam pockets as may form and trust to luck that no fractured castings result.

Manipulation of the cooling water in this way is not necessary when it is possible to recirculate because it is not necessary to take in additional water from the sea.

In the employment of the recirculating system some precautions should be taken. The extensive use of copper or brass pipe will shorten the life of the engine cylinder jackets and other ferric parts through which the water flows unless zinc banks are arranged in sufficient number to neutralize the electrolysis. The overboard valve should be so arranged that it is impossible to stop the flow overboard without opening the bypass to the pump suction simultaneously. A safety or snifter valve should be installed in constant communication with the cylinder jackets so that when the temperature of the engine is being maintained while the engine is stopped and it becomes a closed system there can be no danger of damage resulting from the engine being started and heating the water causing expansion of the water, excessive pressure and fractured jackets. It is not expected that it will be used as a closed system for long but sometimes the engines are on "stand-by" for half an hour or more. At such times the water in the system will be cooling and contracting slowly which may draw in a certain amount of air at leaking pump and valve stem glands. A centrifugal pump may become air bound. To prevent it an air ejector may be installed ahead of the pump. This little device is sometimes helpful on tankers and other ships with engines far in the stern for when running light, and they back, the propeller kicks up a froth that often binds the pumps with air.

One designer installed a separate line from each exhaust valve cage to a header which is in turn piped to the pump suction thus accelerating the flow through the cages. He has also taken a small pipe line off the highest point in each cylinder jacket and from all of the high points in the exhaust manifold intending to destroy all possibility of steam pocket formation by leading these pipes to the suction of the circulating pump as well.

The Trend of Marine Oil Engine Design

A Discussion Covering Modern Developments in Fuel Injection Systems with Special Reference to the Airless Injection of Fuel

SOME five or six years ago the problem of fuel injection seemed almost to have reached finality. The majority of large engines employed air injection, while engines of less than 50 hp. per cylinder were provided with the simple pump timed system of solid injection. Then a manufacturer came into the field with an engine of higher power per cylinder than any that had been previously put to service and fitted with airless injection. This engine not only had a very high mechanical efficiency with a lower fuel consumption, but due its requiring no air compressor it was lighter and cheaper than any of its competitors. This competition set designers throughout the world the problem of either improving their air injection systems or of developing an airless injection system which would give results equal to or better than those obtained by the engine in question. Most manufacturers adopted both courses with the result that there has been a very marked improvement in the fuel consumptions obtained with air injection and at the same time many systems of airless injection have been evolved with varying success.

The improvement in air injection systems has been obtained as the result of experimental research on the detail design of both pulverizers and sprayers and no radical departure has been made from the two well known types of pulverizers, i. e., the plate pulverizer, as used in the majority of designs and the differential pressure type of pulverizer. The general effect of these improvements has been to get more even and complete combustion at the beginning of the expansion stroke, reducing after burning to a minimum, with a consequent improvement in the thermal efficiency. At the same time the quantity of injection air that is required has been considerably reduced. This allows of a smaller compressor being used in that the mechanical efficiency of the air injection engine has been increased. Both of these factors have improved the consumption per b.hp. so that in regular service the air injection engine can show results equal to or better than the best that can be obtained with the epoch-making system of airless injection mentioned above, although on test bed the latter can be tuned up to give results at least some 5 per cent better than any air injection engine. The difference in test bed and service results with the epoch-making system is no doubt due to the quick deterioration of sprayers using such a high oil pressure as 8000 lb. per sq. in.

Other designers attacking the problem of airless injection have tried to simplify the system; this airless injection arrangement with its high pressure fuel pumps and cam operated valves, possesses obvious disadvantages if equally good results can be obtained with a lower pressure and automatic valves. Of existing airless injection systems the Doxford system is one of the best known, and it scarcely needs to be described here. Some of the other systems that have been developed, however, are worthy of closer discussion than they have yet had. The simplest and, on paper, the ideal, system is the pump timed direct injection with automatic valves which has been used for so long on small engines. In practice, this system does not give the results that might be hoped for. To obtain even moderately good results the sprayers must have very small holes with which the fuel penetration is very limited so that on any but the smallest engines multiple valves would have to be used to get the good fuel distribution needed if high mean indicated pressures are to be obtained. This complication with its switchback of high pressure oil pipes would alone be sufficient to condemn the system for large engines, but a further trouble which makes it a difficult system for use on a marine engine is that the sprayers become carbonized very quickly and must be cleaned after every 50 or 60 hours' running, if good combustion is to be maintained. This trouble is due to dribbling of oil through the sprayer caused by the sluggish opening and closing of the valve.

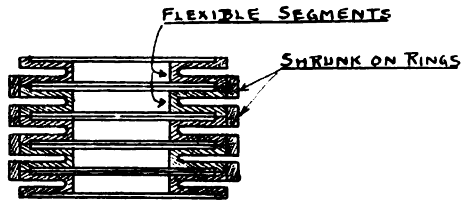


Fig. 1. *Hesselman valve spring*

Various attempts have been made to overcome the difficulty of sluggish closing of the valve by controlling the end of the fuel pumps' effective stroke by means of a spill valve. These have met with varying success, but none of them has completely cured the trouble, and although some may run for considerable periods without the need of cleaning the sprayers, they all suffer from a considerable increase in fuel consumption (about 5-10 per cent) after the engine has been running for a few hours.

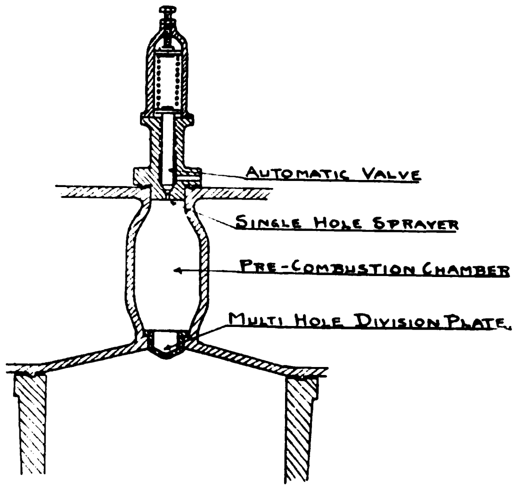


Fig. 2. *Valve and pre-combustion chamber*

One of the most interesting types of valve, using pump timed injection, is that designed by Hesselman. A very small valve dift is used with a valve of large diameter. This is made possible by the special type of spring (a sketch of a portion of the spring is shown in Fig. 1) which consist of a series of annular stiff diaphragms held together by shrunk on collars. This spring has the additional advantage that no fuel valve gland is required. The low lift valve certainly gives very sharp opening and closing but suffers from a serious defect in that, due to its large diameter, it must be placed some distance behind the sprayer so that there is a considerable volume of oil between the valve and the sprayer. This large volume of oil is liable to cause dribbling after the valve has closed and carbonization will result. The Hesselman valve, in the opinion of some people, has serious disadvantages from the practical engineer's point of view, as the diaphragm spring is very long and is liable to be damaged if not handled carefully, while the large low lift valve is even more liable to derangement by particles of dirt than is the fuel valve of other solid injection systems.

A system of fuel injection that has met with considerable success on relatively small engines, and which shows considerable promise for the larger engines, due to its simplicity and its reliable operation in service, is that in which a pump-timed injection system is used in conjunction with a pre-combustion chamber. Fig. 2 gives a diagramatic arrangement of such a valve together with its pre-combustion chamber. As will be seen the latter is divided from the cylinder by a multi-hole division plate not dissimilar from the multi-hole sprayers often used with air injection, though the holes are considerably larger.

This injection system works in the following manner: The fuel valve is provided with a single spray hole of large diameter through which the fuel is forced by the fuel pump at a comparatively low pressure. This gives a coarsely divided spray of fuel, most of which is carried to the lower end of the pre-combustion chamber. In passing through the air in the pre-combustion chamber (heated by the compression to 500 lb. per sq. in. from the working cylinder) some of the fuel is burnt. This causes a very considerable rise in pressure in this chamber so that the hot products of combustion pass at high velocity into the cylinder carrying with them the unburnt fuel which is thus very effectively atomized, so that complete and efficient combustion in the working cylinder is assured. This system of injection has all the advantages of the simple pump timed direct injection without the disadvantage of the small hole fuel sprayer. The single large hole through which the fuel is pumped into the pre-combustion chamber suffers very little from carbonization, and not at all from ercsion of the metal. Engines fitted with this system of fuel injection may be run for many weeks at a time without attention to the fuel valves. The fuel consumption claimed for engines fitted with pre-combustion chamber injection is not quite so good as with other systems. Although the results on test may not be exceptional there is no doubt that test figures can be maintained in service, whereas with other systems of which injection service results, fall far below test performance.

The simplicity, small amount of attention required and reliability of pre-combustion chamber injection make it ideal for use in marine engines and it is to be hoped that it will be fully developed in future for that purpose.

So many other systems have been tried that it is useless to attempt to describe them all here. The most successful are those in which the injection is carried out by a spring controlled plunger mounted in the fuel valve housing, the plunger stroke being varied to suit the load. With such a system the opening of the fuel valve is usually cam operated and the closing is automatic. The spring loaded plunger insures a constant injection pressure at all loads so that the engine will run satisfactorily at light loads. (The only other

type that will carry heavy and light loads equally well is pre-combustion chamber injection.) This type of injection reduces dribbling to a minimum so that it can operate for long periods without the need for cleaning the sprayers. The fuel consumption obtained is better than with pre-combustion chamber injection but against this must be set the disadvantage of the extra complication of a system with cam operated valves. Of all the systems that have been evolved these two seem nearest to the ultimate solution of the problem of mechanical injection; in the meantime research on air injection continues and the healthy rivalry between the two types promises well for the future improvement in economy of the Diesel engine in general. Competition always meets development.

Diesel Towboat Dynamic

A NEW Diesel towboat has just been completed by A. C. Brown and Sons of Tottenville, S. I. The DYNAMIC, as she has been named, is 70 ft. long and is equipped with a 4-cylinder, 240-hp. heavy duty Fairbanks, Morse Diesel engine.

Excellent construction and materials characterize the DYNAMIC. Her keel stem, sternpost, outside planks, frame timbers, rails, plank sheer, wearing pieces, etc. are of Jersey white oak, while keelsons, ceilings, deck frame, deckplank, etc. are of long leaf yellow pine.

Steam heated accommodation is provided for ten men and a fully equipped galley as well as toilet and shower have been installed. The boat is electric lighted throughout.

Auxiliaries consist of a 6-8 hp. Hill Diesel, a 4 in Northern fire, bilge and general service pump, an Ingersoll-Rand single stage compressor and a set of storage batteries.

An exhaustive trial run left the builders well pleased with her both as to maneuvering and handling. She is fitted with an A. E. geared hand steerer.

Characteristics of the DYNAMIC

Length o. a.	70 ft. 0 ins.
Breadth molded	17 ft. 6 ins.
Breadth o. a.	19 ft. ½ ins.
Depth molded	9 ft. 6 ins.
Depth of hold	9 ft. 1 in.
Draft loaded	9 ft. 0 in.
Power	240 hp.
Engine speed	250 r.p.m.
Cylinder bore	14 ins.
Length of piston stroke	17 ins.

Diesel Yachting

The Diesel cruiser PASADO MANANA was recently completed at Wilmington by H. C. Carlson for Lee A. Philips, a noted resident of Southern California. She has an o.a. length of 96 ft., a 20 ft. beam and a 6½ ft. draft with a depth molded of 9 ft.

PASADO MANANA is fitted with a 200 hp. Atlas-Imperial Diesel engine for propulsion which gives her a cruising speed of 11 knots at 300 r.p.m. and a cruising radius of over 5,000 miles. Connected direct to the main engine is a 7½ kw. generator, which maintains, under ordinary conditions, a full charge in the 96-cell set of Edison batteries.

Electric Dynamic Company of Bayonne, N. J., has supplied the electrical equipment for the new municipal ferries now building at the Todd Shipyards Corp., Brooklyn.

Winton Business Reaches New High Peak

Present business now in progress at the Winton Engine Company of Cleveland, totals more than $2,000,000 setting a new high peak for this company. During the past six months orders for Winton engines of all types, including auxiliaries, such as generator sets, pump sets and air compressors have been booked in large volume.

The Winton plant manufactures both gasoline and Diesel engines ranging from 50 to 1500 hp. for yachts, workboats, lighting sets and many other purposes. The Winton organization is re-engining the schooner yacht GUINEVERE, owned by Edgar Palmer of New York, with two 500 hp. Diesels, and they are also engining a 126 foot houseboat for Senator Reynolds of Long Beach, N. Y., with two 200 hp. medium duty Diesels.

Radio for Fishing Fleet

Every day the fishing fleet out of Gloucester is given world news by radio through the courtesy of the Bessemer Gas Engine Company, manufacturers of Bessemer Diesel engines. This daily broadcasting enables the fishing fleet to keep in touch with the important events throughout the world and it is a service that has met a warm reception on the part of Gloucester men.

This broadcasting service is through Station WEPS of Gloucester, Mass., owned and operated by Ralph G. Matheson, and has proven so valuable that the Radio Commission which was about to assign this wave length to a large metropolitan broadcaster decided to keep it clear for the fishing fleet. With the advent of this service the fishing ships lying off the Grand Banks, Georges Banks and LaHave Banks are able to time their home trips to meet favorable market conditions.

New Hamburg-American Liners

Of the new Hamburg-American Line motorships SAN FRANCISCO and LOS ANGELES, which were launched at Hamburg in December 1927, for freight and passenger service between Hamburg and United States West Coast Ports, the first—Ms. SAN FRANCISCO sails from Hamburg on March 10 and is due at San Francisco, April 14.

Ms. LOS ANGELES, her sister is to leave Hamburg on April 14 and is to arrive at San Francisco May 21.

Ms. SAN FRANCISCO and Ms. LOS ANGELES are each 430 ft. in length, with a beam of 59 ft., a depth of 37 ft. 9 ins., a tonnage of 6500 tons and 13 kts. speed.

One of the largest and most important motor tankers under construction, the 5000 hp. Sun-Doxford powered Mary Ellen O'Neil of 17000 tons, was launched from the Sun Shipyard, Chester, Pa., on January 23, for the California Petroleum Co.